1945

Analysis of farm size with special reference to Iowa

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ANALYSIS OF FARM SIZE

WITH SPECIAL REFERENCE TO IOWA

by

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A Thesis Submitted to the Graduate Faculty
for the Degree of

DOCTOR OF PHILOSOPHY

Major Subject: Agricultural Economics

Approved:

Signature was redacted for privacy

In Charge of Major Work

Signature was redacted for privacy

Head of Major Department

Signature was redacted for privacy

Dean of Graduate College

Iowa State College

1945

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INTRODUCTION

This study deals with certain problems of farm size, problems which are not new but which have not received the study which they merit. Interest in these problems has come to the fore sporadically in the past few decades. In the United States discussions relative to farm size reached their initial peak in the 1920's, slackened during the depression of the early 1930's and revived again in the late 1930's and early 1940's. Other agricultural problems have been foremost since the outbreak of the war but the subject of farm size has not been submerged. It promises to be a matter of general concern once postwar adjustments are at hand.

The subject of farm size is one which has received more attention by the farm management research worker than by any other agricultural economist. Even then it has usually been considered along with a multitude of other factors and the typical farm management study devotes no more than one or a few paragraphs to the subject. Students of agricultural policy have largely skirted the entire problem area. The general economist has set forth certain principles as to the size of the firm but these lost part of their meaning in agriculture because of the special conditions prevalent in the industry. Newspapers, farm magazines and semi-popular writers have made many predictions relative to farm size trends but few of these have been supported by data of any sort.

Certain problems of farm size either are or should be the concern of several groups. They are of special interest to the farm operator,

He is concerned with adjustments in farm size as a means of increasing his income, with the importance of farm size relative to other factors as a force affecting farm income and with the returns from intensive expansion as compared to extensive expansion. Further, some farmers are intensely concerned with changes in farm size from a different angle. Any material increase in the land area per farm has its ramifications in a decreased number of farms and farm families. The latter is likewise of special interest to the small town businessman, the school district, the church or other institutions which are deeply rooted in a rural economy.

Farm size has received little attention from students of agricultural policy. Yet there is no reason why this should be so. Research workers in this field have, in a search for means of supplanting farm incomes in a manner consistent with the general welfare, devoted major efforts to such studies as pricing policy. Certainly adjustments in farm size represent a means of achieving or maintaining adequate farm incomes in a manner consistent with the best use of the nation's resources. Yet some students of policy shrug this off with the statement that society is in favor of family-sized units. An adjustment in farm size may not necessarily presage doom to the family unit. Perhaps it more nearly requires an adjustment to bring many units up to a family size, both from an income and labor use standpoint. The student of agricultural policy should have this and other basic knowledge before he investigates other means of treating agriculture's income problem. For example, he should know whether farm size adjustments would result

in adequate farm income while allowing agriculture to stand on its own feet on a price basis. He should at least know whether size adjustments would require more or fewer family farms. This information is basic for the formulation of sound national policies.

This study focuses on two somewhat related but still different problems of farm size. The first has to do with trends in farm size as measured by acres. The second has to do with the relationship of income to farm size as measured in any manner whatsoever. In addition, the study includes a more general and deductive section dealing with the economics of farm size. It was not originally planned that the last mentioned section would be included in this study. However, after the review of literature and the analysis of farm size trends in Iowa had been completed it was felt that there was a dire need for something of this nature.

It is hoped that this study can be used to furnish basic information to farm operators, students of agriculture and other groups directly affected by trends in farm size and by the relationship of income to farm size. Further, it is hoped that it will be of some value to those concerned with devising sound national policy.

REVIEW OF LITERATURE

Changes in size and the relationship of income to size are interrelated problems in the theory of the firm. However, since these two problems have ordinarily been studied separately in agriculture the review of literature follows a similar demarcation. The literature cited does not exhaust the list. Only enough different citations are given that an understanding of the literature is possible. Research studies and popular articles mentioned were selected as representative of (1) different periods of time, (2) different types of studies, and (3) the viewpoints of different individuals.

Changes in Farm Size

Interest in the problem of changing farm size did not come to the fore in the United States until a relatively few years ago. This is easily explainable. There was no reason to be alarmed over changing farm size as long as a pioneer frontier existed. The individual who aspired to farming had the opportunity of moving to an unsettled region. Once lands suited to farming were fully settled, however, interest in farm size was kindled. Any marked increase in average farm size must now be accompanied by a decrease in the number of farms. Too, another development followed close upon the heels of a near-full land settlement. New machines were being invented and old inventions were being improved.

These two things, exhaustion of the supply of public lands suitable to farming and the development of mechanization, brought forth much interest in farm size especially during the 1920's. Any change in farm size resulting from mechanization was certainly in the initial stage. Yet many predictions and speculations as to future trends in farm size were made. There was, of course, little if any data to support the many contentions. Most writers were drawing a parallel between agriculture and other industries in which mechanization had occurred. Many of the predictions and opinions were contradictory. Even today, some fifteen to twenty years later, the same type of prediction is being made.

Wells (86) was one of the first to suggest that agriculture should be organized on a large scale basis similar to that of other industries. Writing in 1889, he stated that the best authorities in the United States and Europe were coming to believe that the only possible future for agriculture was to be found in large scale units, operated with ample machinery and with labor organized somewhat after the factory system. He looked upon the small scale methods of farming as shiftless and wasteful. Grantham (25) wrote an article in 1919 pointing out certain advantages of big farms over small farms. He mainly emphasized the advantages of buying and selling in large quantities which result for large farms organized under central management. Apparently he expected these advantages to result in a rapid increase in the number of very large farms.

Another early comparison of the large and small farms was made by Coulter (14) in 1910. He stated that the bonanza farms in the Red River Valley of North Dakota had an initial advantage over the small farms. They were able to secure both rebates on grain shipped in large quantities and wholesale prices for lumber and goods purchased in large quantities. The initial advantage was great but this ascendance of the bonanza farm was only temporary according to the author. Small farms made steady progress and were gradually able to utilize land and equipment as economically, or nearly so, as the bonanza farmers. He concluded that the small farm would eventually net greater profits because of the ability of the family to care for more details and that it is most successful as a basis for production and as a sound foundation for a nation of agricultural homes. Similar conclusions based upon an analysis of large land holdings in North Dakota were made by Benton (6) in 1925. Neither of these studies had official data to support their conclusions but were chiefly generalizations based upon a few observations.

Henry Ford (15, 23) made suggestions and predictions as to large-scale farming as early as 1924. He looked upon the small-scale livestock production of the individual farm as highly inefficient. Raising livestock in small units was, according to his views, an utter waste of time and effort. He first suggested that if farmers were to pool their livestock herds they could earn far more than by tending small herds of their own. At the same time he suggested that crop production be only a part-time job combined with industrial work. Later he suggested that dairy farming be performed by corporations. In 1926 he predicted

that either the large-scale corporation would supersede the individual farmer or that groups of farmers would be forced to combine and perform their work in a wholesale manner. This, he thought, was as it should be if the industry were to prosper.

The years 1928 and 1929 brought forth a veritable deluge of writings on farm size. Hundreds of speeches, press articles, and even some journal articles made their appearance. These, like those of previous years, were predictions of things to come in the way of farm size and forms of business organization in agriculture. However, agricultural economists as well as business men, farmers, farm leaders and legislators began setting forth their views. Previous to this time most had been said and written by the latter groups. Empirical studies of farm size changes were still non-existent. The development of mechanization was the important factor in bringing about this large flow of predictions.

Some writers suggested that mechanization would force the large-scale unit or the corporate form of business organization in agriculture. Not all of these looked upon the development as desirable. App (3) expected large-scale and corporation farming to develop at a rapid rate and although it would enhance farm prosperity it would not replace the family farm entirely. Mead and Ostrolenk (50) predicted that the efficient large-scale producers would drive out the small-scale producer even though the latter is also efficient. Nourse (58) expected that although the farm was not so well adapted to large-scale production as other industries a three or four man farm would allow efficient utilization of machinery and labor.

Another group of writers looked upon large-scale and corporation farms with favor. MacMillen (47) was one of these. He foresaw corporation farming as containing enormous possibilities for improving the economic and social status of farmers. By this means he suggested that farming might be put on a parity with industry and that farm incomes might be made comparable to urban incomes. The chief difficulties of agriculture were, according to his views, to be found in too little capital and too many people. The corporation, greater capital, larger units and fewer persons in the industry would largely solve this. He doubted that a family unit too small for an adequate income was worth preserving. He also thought that some persons over-emphasized the independence of the family farm as a justification of its existence since the executives of corporations, for example, were paid employees but retained certain freedoms.. Rowley (62) argued for corporation methods in agricultural production as a means of increasing the efficiency of the industry and of solving the income problem. He expected greater returns due to (1) the greater economy in the use of feed, labor and fixed capital, (2) buying and selling advantages, and (3) a greater specialization of labor. Davidson (17) thought that relatively large-scale units would mean not only technical efficiency but would also invite a better quality of management and that "the best possible social conditions will be provided for the community. There will be good schools and there will be community spirit. This is the type of farming we want. It will do away with slums in agriculture".

A third group of persons suggested that displacement of the family by the corporation or large-scale unit was very possible but looked upon this trend as dangerous. Murphy (55) indicated that the 1930 meeting of the American Country Life Association was principally a denouncement of corporation farming. Speakers included Ex-Governor Lowden of Illinois and James Stone, vice-chairman of the Farm Board. Gee (24) suggested that machinery should be used to lessen the drudgery of farm work and that only small increases in farm size should result. He was opposed to corporation farming and indicated that the contribution of the family farm to the American way of life justifies the retention of the family unit. Taber (70) looked upon the development of corporation farming with alarm. Absentee corporate ownership would, according to him, destroy the independence of agriculture, interfere with the training of youth, detract from community life and inject a labor problem into agriculture. According to an editorial in Agricultural Engineering (2) the acceptance speech of former president Herbert Hoover condemning large-scale farming was well accepted by the majority of the farm magazines. The statement which especially brought forth favorable comment was as follows:

> Farming is and must continue to be an individualistic business of small units and independent ownership. The farm is more than a business; it is a state of living. We do not wish it converted into a mass production method. Therefore, if the farmer's position is to be improved by larger operations it must be done not on the farm but in the field of distribution.

A fourth group of writers did not envision the corporation as a menace to the family farm. They did, however, expect the family farm

to increase in size. Black (7) prophesized that not many corporation farms would develop in the corn belt but that the family farm might be expected to increase to an "efficient size" of from one to two sections. The 160 acre unit would not disappear, he thought, but would come to be looked upon in the same light as the 40 acre farm then was. Although the large-scale unit would have a greater advantage in a lower fixed cost per acre, a better paid and higher type management and in purchasing advantages, the family farm would retain some advantages, according to Black's views. These include a less complex organization and a greater personal interest in the work on the part of labor. Too, such developments as hybrid corn and modern feeding methods were as advantageous on the small farm as on the large farm. He expected the large family farm to result in a greater per family income but to have its social effects in (1) fewer farm families, (2) more agricultural laborers but with incomes above those of many owners and tenants of the day, (3) difficult financing of schools and churches, (4) barriers to those who wish to progress up the agricultural ladder and (5) narrowed community social life.

Holmes (34), in a journal article, indicated that the advantages of large-scale farming were very real, yet he did not expect the corporation farm to replace the family farm even in regions most susceptible to this type of organization. The greatest danger was in wheat areas or other regions in which the farm organization was relatively simple. The place of the family farm was to be maintained because (1) the nature of farming

tasks requires a large degree of responsibility for the individual worker, (2) the seasonal nature of agricultural production does not allow the specialization of other industries, and (3) there is not a great deal of continuity in operations necessary for mass scale productions. He expected an appreciable increase in the family farm and pointed to the following effects of the large-scale family farm should it develop: (1) Community organization and life would undergo a fundamental change. It need not, however, be a poorer community life but would most likely be a richer one. A smaller population in proportion to the land and capital should result in a more intelligent and cooperative population and one constituting a better background for the development of worthwhile community enterprises. (2) A higher use of agricultural resources would result. The large units should become training centers in farm efficiency and in rational organization for farm production and marketing. (3) A greater degree of stability in agriculture would come about. There would be more permanence in the type of farming on rented land and a more rational adjustment of farming to the nature of the land and to the existing economic forces. Such cycles as those for hogs and beef cattle might actually be reduced. (4) Agriculture would develop as a greater power in the councils of the nation as the farm population contained a larger proportion of outstanding and more articulate persons.

Grimes (26) indicated that replacement of the small and medium-sized farm by the large-scale unit was inevitable. By large-scale farming he meant the maximum acreage that one family could farm as a unit. Mechanization might, of course, allow a doubling or other multiplication

of the number of acres in the family unit. The increase in size would, according to him, be limited to the large family unit because the quantity of labor that can be employed advantageously from one center is usually limited to that which the family can furnish. On the other hand, the size would tend to this limit because of the lower costs which accompany large-scale farming under mechanization. Grimes also pointed out that the development of large-scale or corporation farming would have far-reaching effects on community life. Such institutions as churches and schools would center more around the small town and less around the farm community. Banks, stores and other agencies in the town would be affected adversely.

The writings reviewed thus far all date back to 1929 or earlier. Recent concern over the prospective disappearance of the family farm is represented by such articles as that of Johnson (41). Writing in the August, 1944, Journal of Farm Economics, he implies that the family farm is in trouble and may become obsolete. The family farm is defined as one which provides a satisfactory family living as well as allowing savings for old age and one on which the labor and management is provided mostly by the family. This author suggests that farmers may well have to adopt the methods of industry if they are to compete in procuring labor and capital and in keeping costs in line with other industries. This general trend toward greater industrialization and the consequent substitution of capital for men will, he suggests, be accompanied by (1) labor policies involving increased public regulation of hours, wages

and working conditions, (2) difficulty of acquiring ownership because of the large capital requirements, and (3) less consideration to soil conservation. The author favors the family farm because it has contributed much to the stability of Corn Belt agriculture; it stands as a symbol of independence and freedom of action worth preserving; it has developed individual responsibility, initiative and a cooperative attitude among all members of the household; and it has resulted in a feeling of community responsibility unequalled by any other type of agricultural organization. He suggests, among other things, that in order to retain the family-sized unit it will be necessary to (1) make a full use of power and equipment, (2) develop more cooperative ownership, custom hire or exchange in the use of equipment, (3) place greater emphasis on the supply and use of operating capital, and (4) use increased incomes for improved efficiency and family living rather than for capitalization into higher land values.

In 1943 Adams (1) summed up a paper read to the Western Farm Economics Association with the statement that, in his belief, the corporation farm enjoyed an economic advantage over the family farms. On the other hand, the author suggested that social gains more often result from the family farm. He suggests that a unit somewhere between the two above extremes may be most profitable. This would call for an appreciable increase in the number of acres per farm.

A very few empirical studies of changes in farm size or in farm size requirements have been made. Paschal et al. (59) indicate that

a unit of 480 acres appears to be the minimum which will support the average family under average weather, prices and management in Central South Dakota. Clawson et al. (11) state that 200 acres of wheat and 200 acres of fallow are necessary if common types and sizes of equipment are to be handled efficiently. Hoover (35) made a sample study of consolidated farms in Iowa for 1939 and 1940. He estimated that one-half of one per cent of the farms were consolidated in these two years. Many other estimates of the number of consolidations have been made. Representative of these estimates is that of Hendricks (31) who suggests that 6 per cent of Iowa's farm families were left without a farm over a three year period. A 1940 estimate (18) implied that 5000 Iowa farm families were forced off the land in 1940.

Relationship of Farm Size to Farm Income

The relationship of farm size to farm income was a subject which came into consideration by even the very first writers in agricultural economics. G.F. Warren (83) made one of the first studies dealing with this problem. His study in Tompkins County, New York, prior to 1913 indicated that labor income tends to vary directly with farm size. He suggested that this relationship grew out of the greater efficiency with which the large farm used its labor, horses, machinery and other capital. Three hundred acres were, he thought, near the maximum from a standpoint of profitable operation since "it is not often possible to get more than this amount well located in respect to buildings".

Two other early writers, Carver (9) and Taylor (73) indicated similar relationships between farm size and income. Both felt that the medium-sized farm was more profitable than the large farm. No data were supplied as proof that large farms are unprofitable.

An Iowa study (54) based on 1913 and 1919 data concluded that larger farms usually result in higher labor incomes and that a farm should be of at least 160 acres or even 240 to 320 acres if horses and machinery are to be used most efficiently. Taylor and Hurd (71) found that there was a positive relationship between farm size as measured in acres and farm profits for the years 1913 and 1918 and a negative relationship for 1921.

Mighell (51) in a 1924 study of farm organization and factors affecting profits on farms in northeastern Iowa devoted eight lines to farm size. He concluded that the most profitable farm area seemed to be about 140 acres but that the effect of size on profits was not great either for losses or gains in any of the size groups. This last statement is confusing since the effect of size should be important between and not within size groups.

The Iowa Annual Farm Business Association summaries (37) show both greater management returns and a greater net operator income on farms of large acreage except for the years 1930, 1931 and 1932. No attempt is made in these summaries to rank the importance of farm size as a factor affecting farm income. Part of the lower income on the larger farms in the depression years is explainable in the decrease in inventory values of the greater amount of capital.

Pond (61) indicates that farm size is one of the most important factors affecting farm income in Minnesota. This conclusion is based on a summary of 1940-43 records kept by farmers. During favorable years the relationship between income and acres in farm is positive. During unfavorable years, the relationship may well be negative according to the summary of this study.

Hopkins (36) states that net farm income increases with total acreage up to about 400 acres and then turns downward as the farmer's managerial ability is (generally) spread over a greater area than he can handle effectively with present equipment and under the present forms of farm organization. He also states that net farm income reaches a maximum as corn acreage approaches 140 acres in rough areas of Iowa and at a maximum of 180 acres for level areas; net farm income increases with hogs produced up to about 35 litters and with cattle fed up to 160 head. These figures are based on farm accounting data for the years 1927, 1928, 1929 and 1930. It is entirely possible that the farm which had reached a maximum corn acreage on the basis of these averages also had a maximum number of hogs, beef cattle or dairy cows.

Mosher and Case (53), in a study of 57 farm records for the nine-year period, 1925-34, concluded that farm size was unimportant as a factor affecting farm income. The measure of size employed was acres. There is some doubt as to the validity of the method used. Actually there was little variation in the size of farms studied. The lower group averaged 234 acres as compared to 244 for the higher group. Other tables in the same study suggest a relationship between size and income.

Other summaries of Illinois farm record data show a positive relationship between farm acres and income. For example, a 1942 summary of 12 years' records (16) indicates that farm size as measured in acres was closely related to farm income and the rate earned on investment.

Warren and Cunningham (84) indicate that farm size was a more important factor affecting New York farm income in 1943 than for previous years. The measure of size used was productive-man-work units. An examination of the study would suggest that this conclusion may have come about somewhat as follows: The farms were broken down into four size groups for 1943 and for previous years. The average incomes of these four groups were plotted against size and connected by a ruled line. Although both the long-time data and those of 1943 showed a positive inclination, the line for 1943 was highest on the graph. Actually this does not have to mean that farm size was more important in explaining variations in farm income in 1943 than for previous years. The relationship of these two lines means only that a unit of size added more to income in 1943 than for previous years. On the basis of this statistical technique, one could not say that income was more closely associated with size in 1943.

A very few studies directed primarily at the relationship between income and size have been made. McMains and Cockerill (47) studied the relationship of farm size and farm type to income in one county of New Mexico by use of the budget technique. Farms were grouped by acres and the average annual gross income expectancy (estimate) was drawn up

as an aid in county planning. Hampson and Christopherson (27) also used the budget method to estimate the returns for small, medium-sized and large farms in the spring wheat area of South Dakota. The authors look upon farm size as one of the most important factors making for success or failure in farming. They classify large farms as those of 800 acres, medium-sized as 480 acres and small farms as 300 acres. Estimated expenses and income are compared under different systems of farming for each of the three farm sizes.

Most of the studies cited have one thing in common. The statistical procedure used has been to sort the farm data according to size, compute the average income for each size group, then regroup the farms according to many other factors and show the returns for these groups. For this reason farm size receives only a small amount of attention in these studies and no quantitative statements can be made about its importance.

The type of farm business analysis pioneered by Tintner (74) is an important exception to this procedure. By means of a more elaborate statistical technique he derived production functions from 1942 Farm Business Association records in Iowa. The total product or dependent variable was gross profits. The factors chosen as the independent variable were land, labor, farm improvements, liquid assets and working assets. The regression equation used was a function which is linear in the logarithms. Four different types of farms were analyzed and a statistically significant correlation existed in each case. The portion of the variation in gross profits explained by the independent variables

ranged from 62.6 to 72.7 and averaged 67.1 per cent. The regression coefficients or elasticities indicate the percentage change in gross profits associated with a one per cent change in each independent factor. The marginal productivities were positive in most cases and there were decreasing returns to scale for all types of farms except dairy. Had it been possible to include management in the analysis returns to scale might have been constant.

The statistical technique employed in the above study is indeed a needed step in the direction of refined analysis. However, the practical application may be limited. The farmer is not so much concerned with gross profits as he is with net income. It is entirely possible that an increase in one factor may bring forth a positive increment to gross profits but a negative increment to net income. Scale of operations may well be less closely associated with net income than with gross income. The nature of the relationship may also be altogether different in the two cases. Too, the analysis does not provide any one common denominator of size for the study of other problems associated with scale of operation.

THE ECONOMICS OF FARM SIZE

A major share of the "large farm" predictions over the past two decades have revolved around mechanization. The "large farm" prophets have reasoned somewhat as follows: The adoption of mechanization requires a high first investment in power units and complementary equipment. Paralleling this investment is a large fixed cost in the form of interest, depreciation, taxes, housing and insurance resulting in high unit costs for the small operator. On the other hand the large-scale operator is able to spread the high fixed costs over many acres so that his unit costs are low. The small-scale operator cannot adopt the new technique, maintain the original scale of operations and survive in competition with the larger unit because of the difference in production costs. Neither can the small-scale unit survive by retaining the less efficient technique prevalent before the innovation. This again is due to the fact that the large-scale unit can produce and sell at a lower price because of the favorable costs accompanying the adoption of mechanization.

The above reasoning implies the static theory of the firm. It does seem rational at first glance. However, an examination of farm size adjustments indicates that changes have not been as great as one might expect on the basis of this static analysis. Mechanization has not been as great a force as was originally supposed or as some are still

predicting. For this reason the immediately following pages are devoted to a twofold purpose: First, the theory of the firm under competitive conditions is reviewed in order to indicate the changes in farm size which might be expected were adjustments to mechanization conditioned only within the traditional framework of assumptions.[1] This analysis accounts not only for the static theory of adjustments but also for the dynamic theory. Second, an analysis of additional forces conditioning farm size adjustments is made since the postulates of neither the static nor dynamic theories of the firm entirely meet the set of circumstances peculiar to agriculture (or to other similar small scale competitive industries).[2]

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[1] For example, two important conditions customarily assumed are that resources are freely accessible and that the supply of factors is continuous.

[2] The term firm has the same connotation in agriculture as in other sectors of the economy. It refers to the decision making unit and may or may not be identical with the physical unit of production, the plant. If two farms are operated as distinct physical units but under the management of one person (or group of persons) only one firm exists. In agriculture the firm and the plant are typically identical. For this reason the term farm is used here as identical with firm. This is not strictly correct but does keep the terminology more manageable.

Briefly, conditions of pure competition exist when the number of firms existing is so large that the production of no one firm can affect the market price, when the buyer prefers one seller over another only in a case of lower prices and when there is free entry or exodus of firm into or out of the industry. Not all segments of the agricultural economy are competitive but the major part can be so classified.

The general outline of this section might well have been different than that followed. The section, instead of being broken down into the two parts indicated, might have been set up as a single theory of firm size within the conditions peculiar to agriculture. However, since the predictions of changing farm size have often implied the unqualified theory of the firm the procedure outlined has been followed.

Theory of Firm Size

Theories relative to the size of the firm can be placed into two categories: The first of these deals with the static theory of production as developed by Marshall (49) and refined to a high degree by such individuals as Viner (82), Harrod (28) and others. The second deals with the non-static theory of production of which the work of Nicholas Kaldor (44), Hart (29), Tintner (75) and others is especially representative.

Equilibrium of the firm under static conditions

The theory of the size of the firm under static conditions rests largely upon the law of diminishing marginal returns and the nature of the demand curve facing the individual firm. In addition, this analysis presupposes that the firm has access to unlimited resources, that the firm attempts to maximize monetary returns and that the supply curve of certain factors of production is continuous. These elementary points require no further elucidation.

In order to simplify the discussion it may be assumed that the firm is producing a single product. Size will be expressed in terms of output for a given time period. The size of the firm under equilibrium conditions may well differ between the short-run and long-run periods.

Size of the firm in the short-run. The "short-run" is generally understood to mean a period of time in which there exists no opportunity to alter the input of the fixed factor. This definition of short-run automatically establishes the nature of the firm's cost curves for the period under consideration. Costs may be divided into two parts: fixed costs which are associated with the fixed factor and do not vary in aggregate amount with volume of output and variable costs which are associated with the variable factor and which do vary with volume of output. From these two types of costs all the important short-run cost curves may be derived (Figure 1). Average fixed costs (afc), a rectangular hyperbola, must always decline as total output expands since a fixed total amount is always divided by an increasingly large number of outputs. The average variable cost (avc) is a U-shaped curve, falling within the ranges of increasing average returns to the variable factor and rising within the range of diminishing average returns of this factor. Average total cost (atc), the sum of the ordinates of the afc and avc curves, is also a U-shaped curve. It declines for ranges of output in which either both avc and afc are declining or in which afc is decreasing by a greater absolute amount than avc is increasing. Conversely, it increases as soon as the increase in avc is greater than the decline in afc. These relationships hold true for

any firm having appreciable variable costs. Finally, marginal cost (mc), the first derivative of total cost, declines as long as total output is increasing at an increasing rate and increases as soon as total output begins to increase at a decreasing rate. The mc represents the increment to total costs as a unit of output is added. Thus if the atc is falling the mc must lie below it; if the atc slopes upward the mc must lie above it. These two curves are necessarily equal at the minimum point of the atc. Similarly, these same relationships exist between the avc and the mc.

The nature of the costs as set out above, along with the nature of the demand curve facing the individual firm, automatically determine the optimum output in the short-run. Under competitive conditions marginal revenue, the addition to total revenue attributable to a unit increase in sales, is identical with selling price. Profits are maximized when output is such that marginal cost equals marginal revenue.[1] Consequently, the size of the firm in the short-run and as measured by units of output is established by the equation of selling price and marginal cost.

A review of literature readily indicates that the size of the firm is more generally envisioned in terms of input of the factor considered as fixed in the short-run. The foregoing discussion of the scale of output in the short-run is one measure of size -- yet it is only indirectly

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[1] If selling price is below the minimum atc but above the minimum avc the firm can minimize losses in the same manner. If selling price is below the minimum avc the firm can minimize losses by ceasing production.

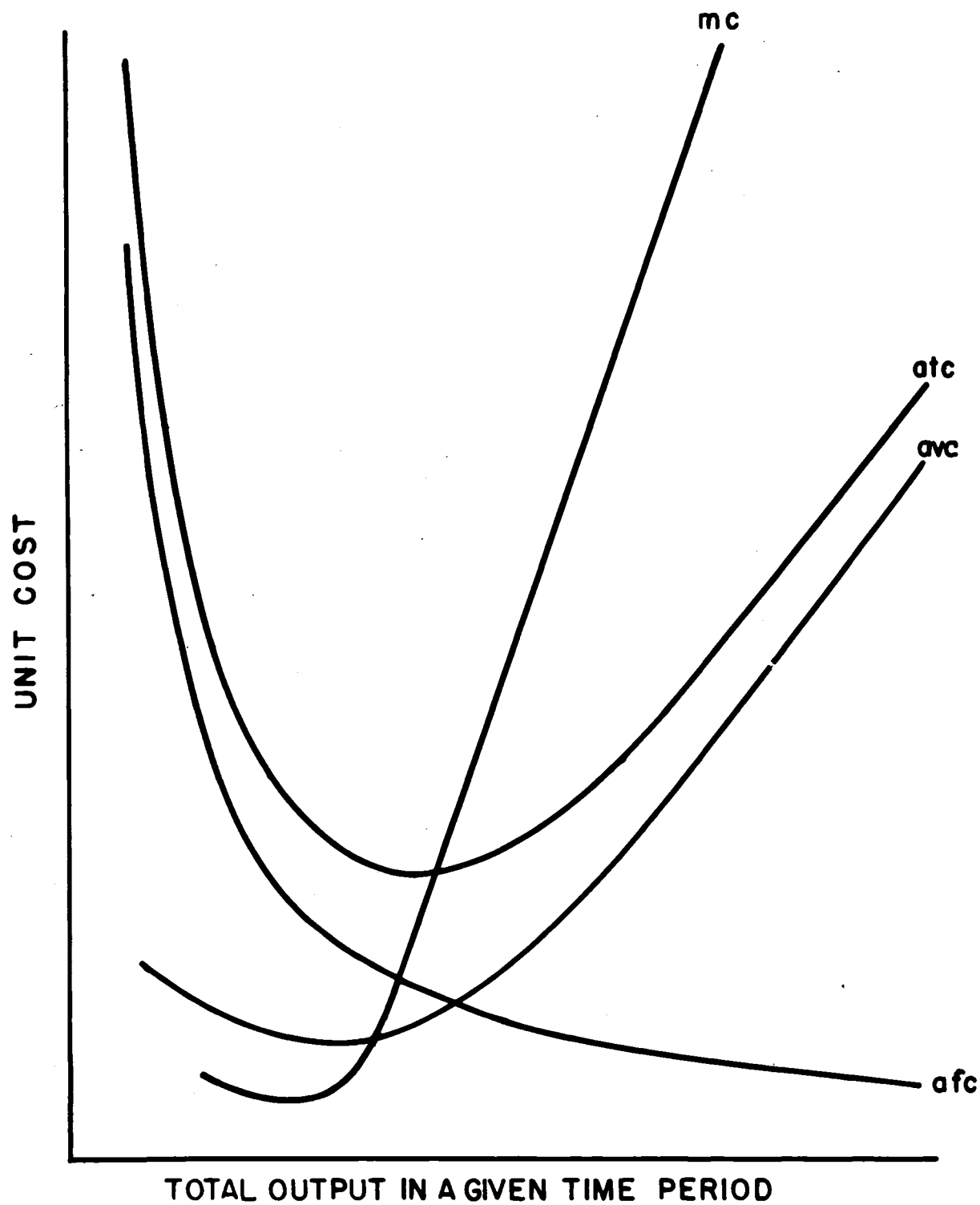

Figure 1. Short-run cost curves.

related to size as measured by the fixed factor. Nevertheless it is a near-indispensable step in developing long-run trends in the size of the firm.

The optimum output in the short-run is not necessarily coincident with that of the long-run. The two never coincide under situations in which selling price is either above or below the firms minimum atc. In case the selling price is equal to the minimum atc, the optimum output for the short-run may or may not be identical with that of the long-run as is brought out in the paragraphs immediately following.[1]

Size of the firm in the long-run. The distinction between fixed and variable factors tends to disappear if a sufficiently long period of production is taken into consideration. Actually, the long-run is defined as a period in which it is possible to vary the factors considered as fixed in the short-run.[2] This distinction serves as a useful device in the final consideration of the size of the firm under static conditions.

A long-run average total cost curve (ATC) can be drawn as the amount of fixed factors varies with output. This curve is also U-shaped but for reasons different than those for the short-run atc. The downward slope in early ranges of output is due to economies of large scale. These economies may be classified as technological and pecuniary and

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[1] Whether or not it is the long-run equilibrium depends upon the size of the plant for which atc and selling price are equal.

[2] The distinction between long-run and short-run is only one of degree.

may be either internal or external to the individual firm.

Pecuniary internal economies are represented by such advantages as lower prices for materials purchased in large lots. Pecuniary external economies consist of the same type of saving which accrues to the firm because it is part of a large industry. Technological internal economies are represented by savings such as those which result from the full utilization of expensive machines; as output is increased more and more indivisibilities are overcome and either the efficiency of the factors already employed increases or more efficient factors are employed whose employment was not remunerative for smaller outputs. Technological external economies are rare but are represented by the gain accruing to a pioneer farmer as neighboring farmers settle the land, kill the wild beasts and thus lessen crop damage.

Given the state of technology, a point must be reached where all economies are realized and as the size of the firm is expanded even farther it runs into the range in which ATC increases due to the diseconomies of large scale production. These diseconomies can be categorized into the same groups as for economies of large scale.

There is a distinct relationship between the short-run average total cost (atc) and the long-run average total cost (ATC). The firm's atc is the envelope of the family of short-run curves ($atc_{1,2,} \ldots . n$), each of which represents the ideal combination of resources for that scale of plant. Each of the short-run atc's is tangent to the long-run ATC. The ATC is a smooth curve since the number of size of plants is

assumed to be infinite. The point of tangency falls either to the right or left of the minimum point on all atc's except one. There is one short-run curve which will be tangent to the long-run curve at the minimum point on both. As is indicated in Figure 2 a given output may be produced by plants of various size. In general, the same output will have different costs depending on the size of the short-run plant. Figure 2 illustrates this point clearly. An output of OQ_1 could be produced at a unit cost of OC_3 by the firm of size indicated by atc_1. It could be produced at a unit cost of OC_1 by a firm of the size indicated by atc_2. This relatively small output could be produced at a lower cost per unit by the small firm due mainly to the lower total fixed cost. On the other hand, an output of OQ_2 units could be produced at a lower per unit cost by a firm of the size indicated by atc_2 than by atc_1. This is due to the economies of large scale production as outlined above. Obviously, there is an optimum-sized plant for any given output.

According to the accepted analysis, the size of the firm in the long-run and under competitive conditions must be such that the short-run average total cost curve is the one tangential to the long-run average total cost at the minimum point of the latter (atc_2 in Figure 2). The output of the firm of the size indicated will be that which gives the lowest total cost per unit (OQ_3 in Figure 3).

That the firm be of optimum size in the long-run is a necessity under competitive conditions. Otherwise it cannot survive. For example, compare firms of three different sizes as expressed by atc_1, atc_2, and and atc_3, in Figure 3. The selling price confronting each individual

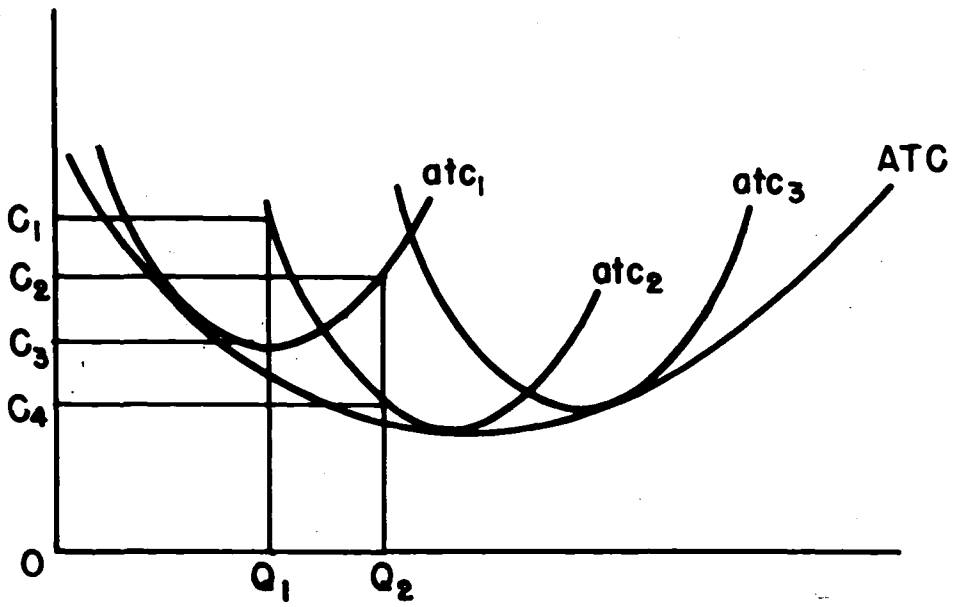

Figure 2. Relationship between long-run and short-run cost curves.

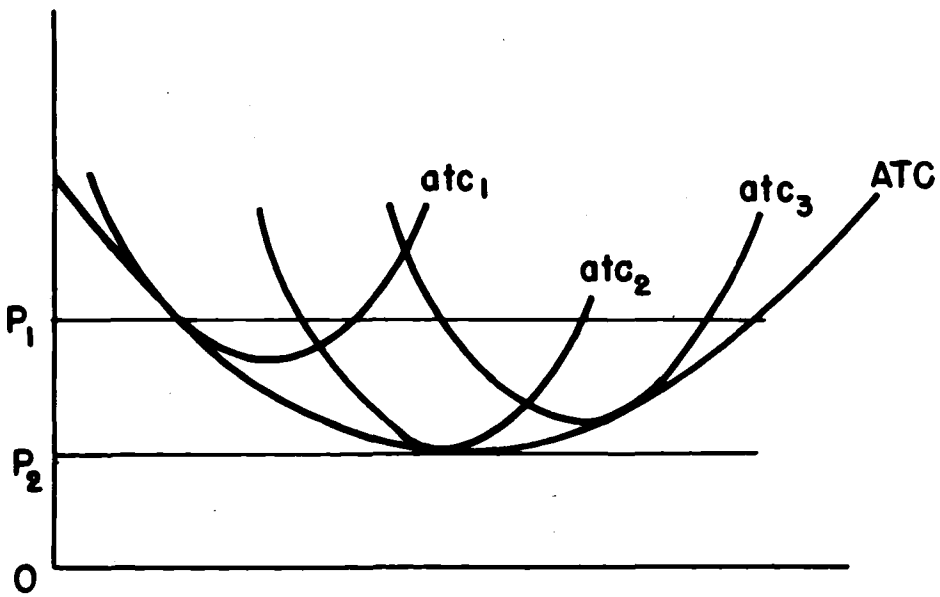

Figure 3. Long-run equilibrium and size of the firm.

firm at the outset is OP_1. All three firms are realising pure profits. New firms attracted by these profits will enter the field, increase supply and thereby lower the market price. Entry of new firms will continue until no pure profits exist in the industry. Non-existence of pure profits is possible only when selling price is equal to the minimum ATC. If the selling price is any higher, firms both smaller or larger than that indicated by atc_2 can exist. However, once a price equal to the minimum ATC (OP_2 in Figure 3) has been established a firm either larger or smaller than that represented by atc_2 will realize a net loss. Accordingly, all firms will adjust to this size or be forced out of the industry. The long-run equilibrium is thus established by a market price of OP_2 and a firm size of atc_2.[1] This is a firm of optimum size in terms of returns to the business and in terms of the combination of fixed and variable factors.

Dynamic economics and size of firm

The analytic tools developed by the static theory of production are useful as tools but are far less realistic than those of the non-static theory of production. This is as true in the consideration of the size of the firm as in other sectors of economic theory. An important part of the spade-work in the theory of the firm under dynamic conditions has been developed by Kaldor (44) and is especially relevant in the

[1] This same type of long-run adjustment would also come about were a price of less than OP_2 to be taken as the short-run starting point.

discussion of firm size. Apropos, Kaldor's analysis parts company with that of static theory at the minimum point of the firm's long-run average total cost curve as is outlined below.

One requirement for the preservation of pure competition in an industry is that the firm's average total cost curve must slope upward after a certain amount is produced. This produces no conflict between the static and non-static theories for short-run considerations. By definition, some factors are fixed in the short-run and costs must eventually rise due to diminishing returns. Too, both theories agree that as the scale of operations is increased in the long-run, the cost per unit must fall within certain ranges of output. Again, this is due largely to internal economies as the indivisibility of certain factors is overcome and/or as productive agents are purchased at lower prices. Under a given state of technology a point must be reached where all technical and pecuniary economies are realized and costs thus reach a minimum. However, it is here where the two theories part company. The dynamic theory indicates that costs may at first rise beyond this point as additional units of indivisible factors are added, but afterwards they must again fall to the same minimum level as before since the indivisibilities are again overcome. Indivisibilities thus cannot explain the limitation upon the size of the firm as long as all factors are freely variable and prices are constant. External diseconomies explain only why the costs of the industry rise and not why the costs of the individual firm rise relative to those of the industry. Any diseconomies which limit the size of the firm must be internal to the firm.

Role of management. A knowledge of the prices of the factors of production and of the production function (excluding management) does not explain the optimum size of the firm, but only the optimum combination of these factors. Therefore, in order to determine the optimum size of the combination, the postulate is necessary that there is at least one fixed factor of production. The determination of the optimum size of the firm is then possible as a result of the principle of diminishing returns. However, it is necessary that the factor whose supply is fixed for the firm must be variable for the industry. Otherwise the industry would have to consist of one firm or at least a fixed number of firms. Accordingly, the fixity of supply must arise not from a market limitation of supply but because of a limitation peculiar to each firm. This means that there must be a factor of which the firm can not have two units simply because only one unit can perform the requisite duties.

Only one factor of production can possibly meet the necessary conditions of fixity. This factor is management. But what characteristics of management meet the conditions of fixity?

Management is variously defined as consisting of two things: (1) supervision, and (2) coordination. The first of these, supervision, is not the limiting factor. If the optimum combination is, for example, one foreman to fifty workmen it may not pay to hire an additional foreman for twenty-five additional workers. Yet if fifty additional workmen and one foreman are taken on, the indivisibilities are overcome and the output should be twice as great (as long as the supervisors of equal ability are available).

This same type of reasoning does not hold true for the coordinating or decision-making factor. The supply of this form of management cannot be increased along with all other factors of production. This is true since each decision must be weighed against all others in the head of the ultimate manager or managers. Even though the altimate management be represented by several persons, such as a board of directors, the addition of one more member does not eliminate the necessity that original members still weigh all alternatives. The firm's long-run cost curve and thus its optimum size is determined by the fixity of the decision-making factor. Decision-making, the ultimate fixed factor, again brings into play the principle of diminishing returns.

Decision making is a dynamic function. It is required only because there is change. Were there no economic change, plans could be carried out day after day according to the original decision. New decisions, and management in this respect, would not be necessary once the optimum plan had been adopted. Too, lack of economic change makes the optimum size of firm indeterminant. The size of the firm could be increased indefinitely in multiples of that existing at the minimum cost point and which is attained when all economies of large scale have been realized (costs would remain at the same minimum for the various ranges of size).

Although a fixed factor, decision making need not be indivisible. The amount of this factor attached to one firm cannot be increased yet there is no reason why this unit of fixed factor cannot be combined with less and less of other factors at increasing returns to the latter. Or in other words, the amount of other factors cannot be increased indefinitely with undiminished efficiency of the fixed factor. It is for this reason

that the firm's costs must eventually increase.

The optimum size of firm is thus established as limited by the decision-making factor and is dependent upon the nature and degree of economic change. The size of the firm may be expected to remain relatively small during a period of rapid change and important decision making.[1] It will expand in periods of little economic change according to the Kaldor (44) analysis.

One additional consideration of dynamics and the size of the firm is in order. It is now necessary to give greater consideration to the manner in which the firm meets uncertainties and the consequences of these actions on the size of the firm.

The static theory makes no distinction between present and future commodity prices or factor costs. Since the theory does not envision change, present and future values can be treated as identical. An equilibrium is thus determinate. Once the concept of perfect knowledge of the future is abandoned, however, anticipations assume an important role. The firm can no longer expect that the optimum output of the present, based on equation of actual marginal costs and marginal revenue, will also be that of the future. The "data" upon which the operations are based must take into account anticipated future costs and prices as well as those of the present. This does not require complete abandonment

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[1] This is somewhat incompatible with the business cycle analysis of Schumpeter (65). According to his analysis a period of change will result in pure profits and thus encourage business expansion. Actually the two ideas may not be inconsistent in all aspects. For example, the revival stage of the business cycle may be looked upon as a period of change but it may be accompanied by less uncertainty, thereby easing the complexity of decision making.

of the traditional concept of equilibrium.

The analysis can now be divided into two parts: (1) when there is certainty as to anticipations, and (2) when there is uncertainty as to expectations. The first case anticipations are single-valued. The entrepreneur thinks that he knows exactly what will happen in the future.

For single-valued expectations the determination of the optimum plan and scale of operations is relatively simple. The optimum scale is simply represented by that plan which promises the maximum present discounted values of anticipated net receipts. Scale of operations will be determined as the discounted marginal cost is equated with the discounted marginal revenue and as the most promising of all alternatives is adopted. The anticipation of either higher prices, lower costs or increased physical productivity will favor expansion of output over that of the present. The converse is true in case lower prices, higher costs or lower productivity are anticipated.

Additional concepts. The assumption of single-valued anticipations is one step in the direction of reality. The second step is the case in which entrepreneurs' estimates for the future are regarded as uncertain. In the latter case a guess may be made as to the general level of future cost or prices but the firm will not have perfect confidence in its estimate. Both risk and uncertainty as defined by Tintner (74) may be involved.[1]

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[1] According to these definitions risk exists when only one probability distribution is involved. This single probability distribution may, for example, be that of future prices or costs. The firm thinks that it is certain as to the type of probability distribution although it may not be certain as to the true value within the distribution. Uncertainty involves two probability distributions. The firm must decide on the most probable of several probability distributions of costs or prices.

According to the analysis of Hart (29) the introduction of uncertainty requires new concepts not recognized under the static theory of production:

1. Expectation schedule: The firm is supposed to have an expectation schedule for prices and costs at each future date. These expectation schedules may well differ between firms. Neither are they necessarily the most probable price. The expectation for each firm is that which it sees as most likely in light of the information it possesses.
2. Dispersion: The firm is supposed to recognize the possibility of various prices and costs higher or lower than the expectation. A probability is supposedly assigned each and the estimates of the near future will show less dispersion than those for later dates.
3. Anticipation of convergance: The firm can expect that the range of its estimates for a given date will narrow as the date approaches. These new concepts introduced by uncertainty will obviously have far-reaching effects on the size of the firm. A difference in expectation schedules or rate of discounting the future may explain the difference in the size of two firms even though they produce the same product, employ the same technology and both have unlimited resources at their command.

The size of the firm at any given date may deviate rather widely from the size of firm which might be considered as optimum in light of the cost/price relationships then existing. This is understandable since the size of the firm at the time t_1 is based on the anticipation of an earlier time, t_0. The divergence between the optimum size of firm and the size of firm actually existing at any given time will tend to vary directly with the

degree of uncertainty which exists in the economy.[1] Moreover, the probability is that the actual size of the firm will fall short of the optimum size the greater the degree of uncertainty. It is entirely possible, however, that the firm's anticipations will lead to a firm of greater than optimum size.

The stratagem with which the firm avails itself in meeting uncertainty may also affect its size. Since the firm expects the range of possible prices (or costs) for any given time to converge as that time approaches and before all decisions affecting input and output have been made, it is expedient that it retain flexibility in plans whenever possible.

By flexibility in plans is meant the postponement of decisions until further information may be available. The retention of flexibility as a means of meeting uncertainty is especially applicable in the case of a commodity for which the production is continuous in time and in which adjustments in scale of operations can be made gradually. For a commodity in which the production is discontinuous the entrepreneur will have to make all his decisions as to volume on the basis of information which is available at the present. This inability to act upon additional information as it becomes available naturally results in a greater divergence between actual volume and optimum volume at any given time. Again, the greater the uncertainty and the downward revision of expectation prices (or costs) the greater the probability that actual volume will fall short of the

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[1] This has a different connotation than N. Kalder's analysis. In this case uncertainty is used to explain the reason why the actual and optimum size of firm may differ. In the Kalder analysis uncertainty is used to explain why the optimum size of the firm is limited.

optimum volume at the time that the discontinuous production period is consummated. These tendencies may be further accentuated in case large layouts in fixed costs are involved. It will pay to avoid or postpone commitments in fixed capital (which must remain idle or operate at a loss in case prices or costs prove unfavorable) even though such would be profitable under today's cost and price expectation but if the dispersion is expected to be less in the future.

The firm may also handle uncertainty in the manner suggested by Stigler (69). A firm certain to produce exactly X units in the future will adopt the short-run plant which will produce this quantity at the lowest cost. This firm will be able to produce exactly X units at a lower cost than will a firm designed to be passably efficient for any output from X/3 to 3X units. On the other hand a production of X/3 or 3X units in the first mentioned plant may come at a higher cost than for the last mentioned plant. This difference in cost relationships depends upon the flexibility and divisibility built in the plant. Thus if fluctuations in costs or prices are anticipated the firm will adopt the flexible unit which may necessitate a greater fixed plant.

It may be concluded that dynamics has much to do with the theoretical size of the firm. The principles as outlined above explain not only why a limitation to the optimum size of the firm exists but also why the actual size of the firm at any one time may deviate from the optimum. Further, they suggest (1) why the size of any two or more firms may be different even though their production situations be identical, or (2) why the size may be identical even though their production situations be dissimilar.

Both could result from different expectations as to future prices and costs. If two firms of identical production situations at a given time t_o expect different prices (or costs) at a future time t_1, the output of the firms may well differ when the time t_1 arrives. Conversely, if at the time t_o firm A with high average and marginal costs expects a higher price (or lower costs) at a future time t_1 than firm B with lower marginal and average costs, the output of the two firms may be identical at the time t_1 even though their cost situations be different.

Adjustments in the size of the firm

Changes in the size of the firm might be explained in terms of either the short-run or the long-run. Short-run adjustments have been left out in the following discussion of changing size since it is the long-run adjustment which is pertinent in this study.

Adjustments under static conditions.[1] The theory of size adjustment under static conditions is easily explained. The adjustment must be caused by a change in the firm's cost situation.[2] Such cost modifications

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[1]This is actually the semi-dynamic adjustment of Marshall (48). In a pure static state no change would take place. This case has been termed "static" to differentiate it from the more complex dynamic change outlined in following paragraphs.

[2]Changes in the firm's price situation in the absence of any change in the cost situation will bring forth adjustments in output. These adjustments in output, however, are only of a short-run nature if the firm's cost curve does not change and if competition exists. It may be true that a change in price will also be the cause of a long-run change in costs. For example, if a large increase in price were to come about the number of firms in the industry (or the size of firms already existing) might increase by much. This expansion in the

may come about through a change in factor prices, a change in techniques or both.[1] An increase in the price of the variable factor while the price of the fixed factor remains constant (or if both increase, a greater relative increase for the variable factor) will shove the minimum point on the firm's average total cost to the left. Accordingly, the firm's new long-run equilibrium will come at a smaller output than before the increase in variable costs. The size of the firm will have decreased since under competition all firms must adjust to the optimum size in terms of costs or suffer a net loss. A decrease in variable costs relative to fixed costs will have the opposite effect; size in terms of output will be increased.

An increase in the price of the fixed factor, with that of the variable factor remaining constant (or if both increase, a greater relative

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(Footnote continued)

amount of productive resources and the competition with other industries may in turn bid up the price of productive factors. Accordingly, any such change in the cost situation for the individual firm will change the point of minimum costs and hence may change the long-run size of the firm. If the expansion of the industry brought about an increase in the relative cost of the variable factor the low cost point would be shifted to the left and firms would, at the new long-run equilibrium, produce a smaller output than before the change in commodity prices and hence the change in factor costs. The reverse will be true in case fixed costs are increased relative to variable costs.

[1] A change in techniques is usually equivalent to a change in the relative prices of the factors.

increase for the fixed factor), will shove the low cost point to the right.[1] The firm's long-run equilibrium will now come at a greater output. Competition will again bring this about. A decrease in the price of the fixed factor will have an opposite effect.

A change in the techniques of production may have the effect of changing the relative prices of fixed and variable factors. For example, an increased productivity of the variable factor will be equivalent to a decrease in the price of this factor under constant techniques. The long-run equilibrium will come at a greater output. Some changes in techniques will change the nature of the firm's long-run equilibrium altogether. This is especially true where a fixed factor is substituted for a variable factor. Certainly the new low cost combination will come at a greater output if the change and increase in fixed costs is great and/or if variable costs are decreased.

Adjustments under dynamic conditions. Adjustments under non-static conditions will parallel those of the static where no change in uncertainties come about. Should either changes in factor prices or the change in techniques introduce more or less uncertainty, the relative adjustment will be somewhat different. If the change is one encouraging expansion in terms of costs and if uncertainties are lessened, the relative

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[1] If average fixed costs represent a relatively unimportant fraction of the average total cost both before and after the increase in the price of the fixed factor, the point of lowest average total cost may remain at the same output. The same qualification is true for changes in the price of the variable factor when variable costs constitute an unimportant part of total costs.

expansion will be greater than if the previous degree of uncertainty were retained. If the change is one encouraging contraction in terms of costs and is accompanied by less uncertainty, the contraction will be less than if the previous degree of uncertainty were retained. This follows from the entrepreneur's discount of the future.

Changes in costs encouraging an expansion but accompanied by greater uncertainty will result in a smaller actual increase than if the degree of uncertainty had remained constant. A cost situation encouraging contraction but resulting in greater uncertainty will encourage a greater actual contraction in output than if uncertainty remained constant.

Furthermore, an increase or diminution of uncertainty with costs or techniques remaining constant may alone cause a size decrease or increase respectively. It is also true that the relative adjustments of individual firms will vary by much depending upon the degree of uncertainty envisioned from a change in costs or techniques. Even though original costs were the same for two firms the adjustment to a new and identical cost situation will not be the same if the two firms discount the future at different rates.

Forces Conditioning Farm Size Adjustments

Any attempt to apply the farm size predictions and their implied static analysis to developments over the past twenty years is doomed to disappointment. This conclusion is obvious once farm size changes are examined.

If mechanization were the major force motivating change and if adjustments took place in the manner suggested in the theory of the firm, farm size adjustments should have been greatest in such areas as the small grain and corn areas. It is here that mechanization has been most nearly applicable. Conversely, it should be the cotton, dairy, range and similar areas in which the change has been least since fewer labor-saving machines have been developed for or adopted in these areas. Table 1 indicates otherwise. The average size of farms in four Nebraska range counties increased by 72.0 per cent from 1920 to 1940 whereas the increase was only 11.4 per cent in six Kansas wheat counties. The size of farms increased by 33.1 per cent in six Mississippi cotton counties while the increase was only 3.4 per cent in four Iowa cash grain counties. Obviously the cost advantages which result from mechanization and which favor the large unit have been greater in the case of wheat than in the case of range cattle production or for corn as compared to cotton. Mechanical developments favored the dairy producer as much as the cotton producer in the 1920-40 period but no such great increase in farm size came about.

It thus seems necessary to look beyond mechanical developments and the static theory of the firm in order to explain the major adjustments in farm size. The dynamic theory of the firm as outlined on the preceding pages is one step nearer reality. Were the economic environment of the firm in agriculture exactly as that set out in the theory of the firm, then farm size adjustments identical with those suggested by the foregoing analysis might have come about. However, not even the postulates of the

Table 1. Change in average acreage per farm by specified counties and farm types, 1920-1940[a]

Area and farm type	Average number of acres per farm		Increase 1920 to 1940	
	1920	1940	Acres	Per cent
Six Kansas wheat counties[b]	244.6	272.5	29.9	11.4
Four Nebraska range counties[c]	1848.5	3179.5	1331.0	72.0
Four Iowa cash grain counties[d]	171.0	176.8	5.8	3.4
Six Mississippi cotton counties[e]	34.1	45.4	11.3	33.1
Six New York dairy counties[f]	118.3	123.3	5.0	4.2

[a]These figures are based on census data (80) and for that reason the averages shown include a type of error brought out in section III of this study. However, an examination of farms by size distributions indicates that the relative changes between areas tend to be as suggested in this table.

[b]Clay, Dickinson, Harper, McPherson, Pratt and Stafford.

[c]Cherry, Grant, Hooker and Thomas.

[d]Hamilton, Humboldt, Webster and Wright.

[e]Coahoma, Le Flore, Humphreys, Sunflower, Tallahatchie and Yazoo.

[f]Chemango, Delaware, Herkimer, Madison, Oneida and Orange.

dynamic theory previously outlined fully account for the situations peculiar to agriculture. Chief among the several special circumstances in agriculture is the imperfection in the market for factors of production. The typical firm in agriculture simply does not have access to unlimited resources; nor is the supply of factors continuous. For that reason two of the traditional assumptions in the theory of the firm, (1) that each firm is able to equate marginal costs and marginal revenue, and (2) that each firm will adopt the optimum scale of operations, must be partially disregarded as keys to size adjustments.

This section represents an attempt to give the subjects of changes in farm size and the determination of farm size a more realistic explanation than has been found true in the unqualified theory of the firm or in the predictions of farm size changes. It is not an attempt to refute the theory of the firm. Actually the theory of the firm is embodied in this analysis to the extent allowed by the traditional postulates. Neither does the analysis preclude certain of the tenets contained in past predictions of farm size change. It does not preclude the possibility that some farms are able to operate at an optimum scale such that marginal costs or marginal revenue are equal or that adjustments are made to the new optimum whenever price/cost relationships change. It does not preclude the fact that although some operators may not operate at the optimum due to lack of capital they will adjust in the direction of any new optimum although they do not have the capital to go the full way.

The analysis is mainly directed at showing that mechanization and lower costs for the large farm does not have to force liquidation of the small unit as is often supposed and that there are also other important forces conditioning farm size adjustments. It is concerned not so much with the few farmers who are able to attain the optimum scale of operations suggested in the theory of the firm as with the greater number who are never able to push to a point such that marginal costs and revenue (or their discounted values) are equal.[1]

Stimuli to farm size changes

The analysis of this section rests more on the truism that an income great enough to meet commitments or to compare favorably with other alternatives is a greater force in farm size adjustments than is the customary firm analysis wherein profits are maximized and the optimum scale of operations is attained.[2] This detour from the classical firm model is made not because the theory of the firm within the traditional

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[1]The analysis is not concerned with changes in farm size which result from shifts in type of farming. It is true that mechanization or other forces may bring about shifts in type of farming and that farm size may thus change from the shift in type of farming alone. However, this is only a special case and need not be discussed apart from the general analysis.

[2]Comparative returns enter into total expenses as an opportunity cost. However, even the inclusion of opportunity costs does not account for the fact that the farm operates at a scale such that marginal costs and revenue are not equated or that the optimum scale of plant is not attained.

postulates lacks logic but because the postulates themselves are unrealistic when applied to agriculture. The heterogeneity of farm size within groups homogeneous as to production conditions and where the managerial ability of the operator does not differ greatly is obvious proof that some individuals either do not or can not adjust to the optimum-sized firm.

Some might question the potency of "comparative" or "necessary" income as forces in the abandonment of farms in the expansion of operations. Common sense, however, indicates that the individual will be more concerned with expanding operations if such promises to fill a gap of 400, 700 or 1000 dollars in meeting interest payments or customary family living expense and which has been occasioned by certain changes than he will be in dreaming about an optimum-sized unit to which he can not expand. Or, he is more likely to abandon his operations in favor of other alternatives if such promises to reward him by 500, 1,000 or 1,500 dollars annually than he is to abandon the occupation when his net income compares favorably with other alternatives but is less than for a farm of optimum size which he can not attain.[1]

Even if common sense cannot be trusted, there is ample evidence to support the above contention. Several recent examples are worthy

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[1] It is probably true that a farm operator will stick to his farming operations even though the returns be somewhat less than what might be realized as a laborer. Yet this is only a matter of degree and does not invalidate the statement made.

of mention. The number of farms in sixteen South Dakota counties[1] dropped by 31 per cent from 1930 to 1940 while the average size of farm increased by 75 per cent. The diversity of farm size previous to 1930 would indicate that not all farms were of optimum size. Yet the alternatives to remaining on the farm, dark as they were during the 1930's, were more effective in bringing about adjustments in farm size for these counties than were the potentialities of an optimum-sized unit or mechanization previous to 1930. The migration from farms which started especially in 1941 further illustrates the potency of the income force. About 940 thousand persons moved from farms in 1941 as compared to 281 thousand in 1940 (79). Only a small percentage of these went into the armed services. The motivating force was the number of more attractive opportunities elsewhere.

"Comparative" income has a special bearing on the size of the firm in agriculture. The spatial factor limits the number of firms which can exist at any one time. Thus some firms can expand acreage only if other operators forsake the industry for alternative occupations.

Mechanization and changes in farm size

As has already been suggested those who predict very large increases in the size of farms as a result of mechanization reason in the following

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[1] As shown by the United States census for the counties of Bennet, Carson, Fall River, Haakon, Jackson, Jones, Lyman, Mellette, Perkins, Stanley, Sully, Todd, Tripp, Washabaugh, Washington and Ziebach.

manner: The use of labor-saving machinery results in a high fixed cost. This high fixed cost gives an advantage to the large-scale producer who is able to substitute the new technique for the old. He is able to produce at a lower cost, has a greater income than before and thus will drive out the small producer whose unit is too small to merit the use of the new machinery. That mechanization has had some important effects on farm size is obvious. Yet the outcome outlined above over-emphasizes the case. This outcome is a possibility but is not a necessity when "comparative" or "necessary" income rather than a maximization of profits for a firm of optimum scale is considered as the key to adjustment. The outcome depends not only on what happens to costs (whether costs are lowered and the low cost point is shoved to the right) but also upon certain other forces. Such forces include the availability of additional lands and the nature of farm tenure. The outcome will vary depending on the combination of these forces.

Available land. The first combination of forces which can be considered includes (1) a mechanical invention which results in a cost advantage for large units, (2) the availability of additional land which can be brought under cultivation, and (3) varying forms of tenure. In order to simplify the discussion it will be assumed that adoption of the new technique does not pay unless the scale of operations is above "average" in size.

The mere fact that mechanization makes possible lower costs on the farm greater than "average" in size should encourage some such farms to adopt the new technique even though they do not change their acreage.

As long as this is the only development (adoption of mechanization by some large farms but with no change in total acreage) the net income of the operator on a farm of "average" size or less will not have changed. The price he receives for the commodity and his gross income will not have changed. Neither will his costs have changed since it does not pay to adopt the new technique on the farm of "average" size or less. If he were to maintain his current scale of operations while adopting the new technique he would diminish net returns. Further, even if some farms do consolidate, the operator on the farm of "average" size or less will not be forced to expand as long as the total acreage of the commodity does not increase.

But suppose the new technique lowers costs by enough to encourage a greater acreage of the crop. This greater acreage may come about either through a shift of land from other crops or through the cultivation of land not formerly cropped. It is then that mechanization will have far-reaching effects on farm size. The greater acreage and production of the crop, where additional land is available, will mean a lower price for the commodity and a lower gross income from a given acreage of the crop. An individual will now be as well off as before the innovation and consequent increase in acreage only if his absolute decrease in gross income is offset by a decrease in costs. Some operators may offset this decline in gross income through a decrease in costs brought about by the adoption of the machine even though they do not expand scale of operations. However, in order that this be possible

the farm must be greater than "average" in size. Otherwise it would not pay to adopt the new machine without increasing acreage. Of course operators who were previously able to and did operate at the point of optimum returns may be expected to adjust to the new optimum.

The tendency will be of a different nature for the farm which is of "average" size or less. It cannot offset the decline in commodity price through the adoption of the new technique while maintaining the same scale of operations. This type of adjustment would have the effect of augmenting the reduction in net income. In order to have an income as great as before the change in mechanization and hence the increase in the total production of the crop, this operator, if he is to remain in farming, must now adopt the machine and expand his operations. He, of course, has another alternative: He can leave farming and turn to another occupation. If the supply of land which can be converted into farms is limited the latter will be necessary on the part of some operators before others are to be able to expand operations.

The operators of both tenant and owned farms of "average" size or less will be affected. The underlying cause of the adjustment, however, will be somewhat different in the two cases. The impact of the lower commodity price should theoretically come to rest on the land. This production factor should now be able to command less in the form of rent because of its inelasticity of supply relative to other factors. The play of competitive forces should thus return the tenant operator as much for his labor and capital as before.

As long as this is true the tenant operator on a farm of "average" size or less will not be forced to expand from a "customary" or "necessary" income standpoint. However, any move by some operators to rent additonal land may eventually cause this tenant farmer to either expand operations or leave the industry. Whereas the initial effect of the lower commodity price was to lessen the marginal product (in monetary terms) of land and leave the shares of other factors at the same level, the adoption of mechanization and expansion of operations by certain operators will lower their costs and restore the bargaining position of land. The tenant on the farm of "average" size or less will then realize a lower net income if he retains the same scale and technique. Costs will remain the same while rents will tend towards the former level.

A hypothetical example can be cited to illustrate these tendencies. A tenant operator has been producing a crop which grossed $30 per acre and for which costs have been $10 per acre. The competitive cash rent which he has paid per acre amounted to $10. This left a net return to other factors of $10 per acre. Now the mechanical development occurs, total acreage is expanded, price drops by 10 per cent and the gross income falls to $27 per acre. As long as there is no wholesale competition for additional land the rent of land should likewise fall by $3 per acre leaving net returns for the tenant operator on the farm of "average" size or less at the previous level. But now suppose that some operators who have adopted mechanization expand operations and by so doing lower production costs by $3 per acre. Perhaps $2 of this reduction may be claimed as rent by land, the factor for which the supply is least elastic. The tenant will now find that rents have gone back to $9 per

acre while gross returns are only $27 and other costs are still $10 per acre. This leaves a net of only $8 for the tenant of the farm of "average" size or less who has retained the same scale and technique. Yet if he were to adopt the new technique and retain the same scale net returns would be diminished even more. If net income is to be kept at the former level, the tenant operator of the small unit will also be forced to adopt the new technique and expand operations. Or, he may turn to other occupations thus paving the way for expansion by others.

The nature of size adjustments for farms of "average" size or less will be almost identical in the long-run for tenant and owner-operated farms. On the other hand the short-run tendency on the owner farm will be different from that already outlined for the tenant farm. The effect of mechanization, greater production and lower commodity prices was, at the outset, to diminish rents and leave the returns for the tenant's capital, labor and management at the previous level. Thus his net income also remained at the previous level since it is made up entirely of the marginal product of capital, labor and management. This is not true for the owner since rent is also part of his net income. Mechanization, increased production and lower prices should have the effect of forcing the owner operator into immediate expansion of operations. The only manner in which he can now realize as great an income as before if he is to remain in farming is to adopt the new technique and expand operations.[1]

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[1] He, too, may abandon farming in favor of other alternatives. This, again, is necessary on the part of some if others are able to expand.

This owner-operator on the unit of "average" size or less must also maintain operations at a greater scale in the long-run. The fact that some persons adopt the new technique, lower costs and are thus able to bid more rent on the land does not alone augment his income. His net returns will remain at the lower level as long as he retains the same scale of operations and same technique. Costs will be the same but gross income will be less than before. Income can be maintained only if the new technique is adopted and operations are extended.

Lack of available land. A second combination of forces which can be considered includes (1) mechanization, (2) lack of additional land which can be brought under cultivation or shifted from other crops, and (3) varying forms of tenure.[1] Again it may be assumed for purposes of analysis that it does not pay to adopt the new labor-saving machine on farms of "average" size or less.

The mere adoption of the new device by a few operators will not necessarily force any small scale operators into expansion from a "customary" or "necessary" standpoint. As long as no other forces are under way the small-scale operator will still have as great a net income as before the invention of the machine. Once a move to expand has started, however, a definite pattern of farm size change may develop depending upon the nature of tenure. If any appreciable number of farms had been able to

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[1] This combination might include mechanization and a complete lack of additional land for the crop in question or mechanization and only an insignificant increase in acreage of the crop.

operate the optimum size unit before the innovation they may now find that the optimum size requires operations on a larger scale and adjust accordingly. But even though this type of expansion takes place by some farms, the small-scale owner-operated farm will not be forced to expand from the "customary" or "necessary" income standpoint. The fact that no additional land (or only an insignificant amount) can be brought into cultivation will leave the price for the given commodity and the gross income to the industry at the previous level. Likewise the gross income for the individual operator will remain at the same level if his previous scale of operations is maintained. His net income will also remain at the previous level since neither costs nor gross income will have changed. Now if the farm is one of "average" size or less and was unable or had no incentive to expand before the advent of the new machine, there should be little tendency to expand after the innovation. Certainly it could not be said that the operator will be forced into expansion. True, the potentiality of adopting the machine, expanding acreage and increasing net income exists. However, the possibility of expanding scale and augmenting income existed before the development of the new machine.

It may be true that where adoption of the new method is warranted, the cost of production will be lowered and the saving will be capitalized into the value of land. This will have no direct income effect on the small-scale operator who continues to operate under the old technique and at the same scale. He will not be forced into expansion and his

income will still compare as favorably with other alternatives as before the innovation.

The reasoning is somewhat different for the tenant on a farm of "average" size or less. The two situations may be similar only at the outset when the new device is first adopted and before any move in the direction of greater scale has been precipitated. The tenant on the farm of "average" size or less will, at the outset, realize as great an income before the innovation. He cannot enhance his income by adopting the innovation while maintaining current scale of operations and he will not have been forced to expand operations or to abandon farming as yet.

However, if rents are flexible and if his level of income is to be maintained, the tenant on the farm of "average" size or less will be forced to expand once any move towards greater scale has begun. Regardless of the factor which initiates the trend, net rents will be affected under the combination of conditions being considered. The lack of new or additional land which can be brought into cultivation will leave the gross returns for a given area of land at the same level as before the innovation. Consequently, the net income must increase as a result of the lower costs on units for which the scale of operations warrants use of the new technique.

The imputation of this incremental net income must then take place. Which production factor can claim it? It will be imputed to land since (1) the competition for land will increase as some turn to greater scale of operations (e.g. those who were operating at the previous optimum

may now expand to the new optimum), and (2) the supply of land is relatively inelastic as compared to other factors in agriculture.

If rents are flexible the tenant on the farm of "average" size or less must now compete with the large-scale operator who can pay higher rents because of his lower costs. The small-scale tenant will have to pay the higher rents or relinquish his lease to the land. This means that his net income will be lower than before the innovation if he retains the current scale of operations (assuming gross income and all costs but rent remain at the same level). In order to bring his income back to the former level the tenant on the farm of "average" size or less must now adopt mechanization, expand operations and lower costs. He will have been forced to expand operations from the "customary" or "necessary" income standpoint.

If rents are not flexible, the tenant operator will be affected exactly like the owner operator. The lack of additional lands for cultivation of the crop will leave the gross income to the industry at the previous level. Due to the inflexibility of rents the tenant's costs will be no greater than before and his net income will remain at the previous level even though he does not expand operations. He will thus not be forced into expansion from the "customary" or "necessary" income standpoint.

Typical cases. Situations representative of the cases outlined can now be pointed out. Mechanization in combination with additional land brought under cultivation is represented by wheat production. Mechanization and a lack of additional land is represented by corn. Of

course, there have been numerous other forces serving to stimulate farm size adjustments in the case of either commodity. These additional forces will be pointed out in a later part of this section.

Mechanization and the consequent lower costs have had far-reaching effects on the United States wheat producer. It has made possible the use of land which was previously submarginal in the production of wheat. It has thus encouraged a greater wheat acreage within the United States and has also accentuated the trend toward a greater production in other countries (Table 2).

Mechanization alone has had no such widespread effects on corn production. The area in which the crop can be produced is more narrowly limited by natural conditions than is true for wheat. Also mechanization has resulted in no great shift of land from other crops to the production of corn.[1] World wheat production jumped by one-third between the periods 1900-09 and 1930-39 while corn production increased by only 11 per cent. The increase in wheat production has likewise far exceeded that of barley and oats, grains which serve as substitutes for corn.

Mechanization has exerted a greater pressure on the income of the wheat producer than on that of the corn producer. As Shepherd (66) indicates, the price of wheat in the United States has fallen relative to the price of corn. Had there been no additional wheat land brought into cultivation as a result of mechanization the pressure of incomes on

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[1]The development of tractors has released some land from the production of feed for horses. Too, hybrid corn has been an important development in the industry. These two items represent a size-force to be outlined in the next section. Even then hybrid corn is a fairly recent development which would require qualifications only when its full fury is felt in an economy lacking production controls and war-stimulated prices.

Table 2. United States acreage and production and world production of corn and wheat by specified periods[a] (millions)

Period	United States acreage		United States production (bushels)		World production (bushels)	
	Corn	Wheat	Corn	Wheat	Corn	Wheat
1900-09	96	46	2613	667	4080	2660
1910-19	102	55	2636	774	4280	2975
1920-29	100	59	2695	822	4629	3422
1930-39	89[b]	56[b]	2209[b]	748[b]	4649	3897

Source: Agricultural Statistics (81)

a. Excluding Russia and China.
b. Not exactly comparable to earlier periods because of acreage limitations.

size expansion would certainly not have been as great as has been experienced. True, corn farmers adopted mechanization and some expanded operations. Yet the rank and file producer was not forced to expand operations from an income standpoint to the extent that has held true for wheat producers.

The effect of other technological changes and outside economic forces

Mechanization represents only one form of technological improvement. It has increased the amount of work which can be performed per person. Another type of technological advance has been equally important in agriculture. It is represented by such developments as higher yielding varieties, disease resistant strains, more efficient feeding methods and improved

husbandry in general. Such improvements have meant a greater yield per animal or per crop acre and while they have resulted in lowered labor requirements per unit of livestock product or crop produced, they have not lessened the labor required per acre or animal.

Although generally overlooked in the discussions, this type of technological change also bears some relationship to farm size. The impetus given to adjustments in farm size by this type of change is only partially similar to that of labor-saving changes.

The effects of this improved technology on farm size are paralleled by those of certain outside forces. Such outside forces include a revision in import duties, the development of substitutes, the opening of competing areas and similar factors which either change supply or demand. In order to keep the following discussion more manageable the term "technological improvement" will be used to include all such forces which are similar in their effect on farm size. The direct parallelisms will be pointed out later.

The effect of this type of technological change on farm size hinges largely upon the elasticity of demand for the commodity under consideration. The following discussion is divided into the cast of (1) an inelastic demand and (2) an elastic demand.

Technological change and an inelastic demand. The first case which shall be discussed is that of an inelastic demand. Accordingly, the improvement in technology will, when widely adopted, decrease the gross income to producers of the commodity since the resulting decrease in price

will be more than proportional to the increased production.[1] This type of improvement will not decrease total costs for the farmer. Total costs will remain the same, or more probably, will increase slightly. For example the advent of hybrid corn meant a higher price for seed and some additional cost in handling the greater yield. It is obvious that this technological improvement in conjunction with an inelastic demand must decrease the total net income for the commodity.

Farms which were operating at the optimum scale in terms of crop acres or animal numbers before the innovation will now find that the optimum unit so measured cannot possibly come at a greater scale than previously. Actually, an optimum unit, when measured by livestock numbers or crop acres, is most likely to come at a smaller scale than before the change. This certainly will be true since total costs per acre or animal will not have decreased.

How will this type of change affect the large numbers of farms which have long existed at a scale of less than optimum size? If rents truly reflect the marginal productivity of land the effect will be somewhat different in the case of tenants than in the case of full owners. The lower net returns should mainly come at the expense of land, the production factor for which the supply is relatively inelastic in agriculture. If rents are thus flexible downward the net income to the tenant farmer

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[1] The only case in which this would not be true is when an equally profitable alternative product exists and if the demand for such a product is not also inelastic.

should remain as great as before the innovation. The return for his labor, capital and management will compare as favorably with other alternatives or will come as near meeting fixed commitments as beforehand and there is no reason why the new situation should prove a stimulus to expanded operations for the tenant farmer.

This will not be true for the owned farm which was operated at a scale of less than optimum before adoption of the new technique. Regardless of the flexibility of land rents the net income of the owner operator will have suffered a reduction since the rent of the land is a constituent of his net income. In order that the returns to this group compare as favorably to other alternatives or come as near to meeting commitments as previously it will be necessary that their operations be expanded.[1]

The two groups of farmers will be affected similarly when rents are not flexible. Such inflexibility often holds true in the case of share rents. The traditional share such as one-third, two-fifths and one-half tends to remain unchanged regardless of the economic situation and the share which is attributable to each production factor. The different economic situations are, however, somewhat reflected in the cash which is purportedly paid for the use of pasture, lots and buildings and which does vary from year to year. In case the rent is not flexible in the

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[1]This is possible only in case additional capital is forthcoming. The role played by capital rationing is discussed in a subsequent section. The fact that the farm was of less than optimum size suggests the possibility of using more labor and capital to augment income.

downward direction, the tenant will be affected exactly the same as the owner. His net income will have been decreased and in order to restore it to its former level he must expand operations or move into alternative lines of work.[1]

Technological change and an elastic demand. The second case which can be discussed is that of an elastic demand. It has no such strong influence on the tendency to increase farm size as does an inelastic demand.

The combination of technological improvement and an elastic demand will have the effect of increasing net returns for the commodity in question. If rents are flexible the tenant will pay a proportionally greater rent for the land and his net income will remain at the former level. If rents are inflexible such as may be true for crop-share leases the net income of the tenant will be augmented. In neither case will the tenant be forced to expand operations in order that returns compare as favorably with other alternatives or come as near meeting commitments as previously.

This combination of forces will certainly increase net returns for the owner operator. He will not be pressed into a greater scale of operations from the "comparative" or "necessary" income standpoint. Were the change severe enough it is possible that land values might increase

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[1] An inelastic demand and a lack of close alternative enterprises would mean lower land values which in turn would make possible a larger unit with a given amount of capital. This would be meaningful, however, only to the person who had not previously invested in land but does so after the change.

sharply thus also diminishing the size of the unit which could be purchased with a given amount of capital.

Other forces. That the effect of a change in technology which increases output per acre or animal is similar to the effect of certain outside forces on farm size can now be clearly pointed out. Without further elucidation it is obvious that an inelastic demand in connection with an improved technology is equivalent in nature of effect to either an elastic or an inelastic demand in combination with any one of the following situations which lower the price of the commodity: (1) a reduction in tariffs which favors an inflow of foreign produced commodity, (2) the development of substitutes or (3) a decrease in demand for any reason whatsoever.

On the other hand the combination of an elastic demand and an improved technology can be likened in effect to any decrease in supply of competing commodities or any increase in demand for the given commodity. The combination of technologic improvement and elastic demand will result in a greater income even as the price of the commodity is lowered since the increase in output will be more than proportional to the decline in price. The last mentioned forces will increase income through a higher price for the given commodity while output remains constant. Income will be affected similarly in the two cases.

The business cycle might be looked upon merely as a force affecting the supply of, or demand for, farm products and thus be included in the analysis just outlined. However, because of its peculiarities, the depression phase of the cycle merits individual attention as a factor

affecting farm size. If there is widespread unemployment elsewhere in the economy and if the fall in farm income is merely proportional to the decline in income elsewhere, the major effect of the depression is likely to be that of holding operators on their farms while arresting any tendency on the part of these operators to expand operations. The upward tendency may be arrested by any one or combination of forces such as greater uncertainty and lack of ability to acquire capital. On the other hand, a decline in income for an area more than proportional to incomes elsewhere[1] will likely force some farm operators into other jobs (or possibly to resort to relief) thus paving the way for remaining farms to consolidate and expand operations in the hope of augmenting their diminished incomes.[2] These tendencies are all noticeable in census data for 1930 and 1940.

The depression may have numerous other impacts on farm size. It may result in many foreclosures and consolidations by loaning agencies as is suggested in studies such as that by Murray (25). It also results in a move to small subsistence homesteads or part-time farming units as is indicated by the increased number of such farms from 1930 to 1940; and it may serve as the final impetus to a shift in type of farming and, in turn, farm size. Furthermore, prices will probably fall at a faster rate than costs thus penalizing large-scale operations. The latter is revealed

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[1] This situation is exemplified by the South Dakota case cited earlier.

[2] To the extent allowed by the uncertainty and degree of capital rationing which exists.

in farm business record data such as those in Iowa (37) and Minnesota (61).[1]

Finally, any natural force which tends to lower the net farm income of an area relative to other alternatives will tend to result in a consolidation of farms. For example, a continued drought may be very effective. Likewise a continued state of soil erosion and depletion in an area will lower income and may force some operators from their farms thus opening the road to consolidation by others.

Typical cases. Two of the farm types mentioned earlier parallel the major cases outlined above. The case of cotton is analogous to that set of forces represented by "technological improvement and an inelastic demand".

Cotton has been affected by several forces of the "improved technology and inelastic demand" nature. Some improvement in yields has come about. Certain sections, especially the Piedmont areas of Georgia and Alabama, have suffered extremely from soil erosion. Bennett (5) indicates that from four to eighteen inches of top soil has been lost from 60-65 per cent of the region. This soil depletion and consequent lowering of incomes has been accompanied by a decrease of 50,000 farms and has thus allowed an expansion by others.

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[1] This may appear incompatible to the earlier statement that some farms may expand. Such is not the case between areas. An examination of farm records and census data indicate that both of these statements hold true, depending on the nature of other forces at work in the area.

Table 3. Average annual cotton production, world and United States, and United States exports for specified periods

Period	Production (1000 bales)		United States net exports (1000 bales)
	World	United States	
1910-19	20,398	12,860	7,502
1920-29	23,959	13,124	7,426
1930-39	28,381	13,458	6,617

Source: Agricultural Statistics.

A very important force is to be found in foreign competition. Other parts of the world have increased production while United States' exports have dropped rapidly since 1920 (Table 3). Too, the "Old South" must now compete with newer areas within the United States.

Larger farms are developing in the old cotton area, not because mechanization has been an important force to date, but because numerous other forces have pushed incomes of cotton producers downward. Further adjustments in farm size must still come about if cotton producers are to stand on their own feet in the future.

A force of a different nature has been operative in the dairy areas of the nation. Although the dairy areas, like the old cotton areas, have not seen rapid strides in mechanization, they have not been without technological change. Elwood et al (21) show that between the two periods 1909-13 and 1937-40 milk production per cow increased from 4,551 to 5,435

pounds in the Eastern Dairy Area and from 4,466 to 5,298 pounds for the Western Dairy Area of the nation.

Why has not this increased productivity for dairy products had an effect similar to the non-mechanical forces affecting cotton farms? The explanation lies in the fact that while the cotton situation parallels the case of "improved technology and an inelastic demand", the dairy situation more nearly parallels the case of "improved technology in conjunction with an elastic demand". At least the demand for dairy products has been increasing with a growing population and in the absence of effective international competition. The price of dairy products has remained at a higher relative level than has the price of most other groups of agricultural commodities (Table 4). Thus the combination of improved

Table 4. Average index of prices for specified commodities, 1920-29 and 1930-39 (1921-25 = 100)

Commodity	1920-29	1930-39
Dairy products	105	71
Cotton products	88	55
Wheat	97	63
All grains	109	66

Source: Agricultural Statistics

technology and a greater elasticity of demand has not made necessary the farm size adjustments which have held in the cotton areas.

Other combinations could also be pointed out. The decline in exports of wheat has augmented the effects of mechanization in bringing about size adjustments for wheat farms. The effect of hybrid corn might eventually be that of forcing expansion of corn belt farms. This may especially be true should the demand prove to be inelastic in a normal economy lacking in production controls and price supports. Enough cases have been cited, however, to suggest reasons for patterns in farm size adjustments.

Certain conclusions are now in order. Mechanization, the force usually stressed, may or may not force size adjustments. The outcome depends on the availability of additional land. Other forces can be equal to or greater than mechanization in forcing size adjustments. These are the logical conclusions when the analysis is based not on the assumption that each firm is able to adopt the optimum scale of operations but on the more realistic assumption that the greatest numbers in agriculture are limited to a scale of less than optimum.

Capital rationing and farm size

The foregoing discussion has focused on forces which tend to bring about adjustments in farm size. The discussion immediately following is focused on forces which tend to prevent adjustments in the direction of the optimum-sized farm. Of course, once these limitations are lessened they allow adjustments in size.

A basic postulate employed in the theory of the firm is that all firms have access to unlimited resources. Under these assumptions it is possible for the firm to maximize returns by equating marginal cost

and marginal revenue. This supposition is highly unrealistic in agriculture.

The majority of farm operators is prevented from attaining an optimum-sized unit simply because they do not have and cannot (or do not) borrow the capital to do so. Capital is not so freely accessible as is assumed in the theory of the firm. It is rationed to the farm operator either by himself or by credit agencies.

The greatest number of farmers probably push the size of operation to the limit allowed by the capital which they own or can (or are willing) to borrow. That this is often the case is evidenced in an Iowa study (43). Farmers grouped according to level of income were questioned as to why they did not expand operations. Eighty-one per cent of the low income farmers (the lower one-third) stated that their scale of operations was limited by a lack of capital. Only 24 per cent of the high-income group and 53 per cent of the middle income group indicated capital as the limiting factor. However, capital was probably the limiting factor for a greater number than the above figures indicate. A relatively large number in all groups stated that lack of labor was the limiting factor in scale of operations. However, had the capital been available they could have hired the labor needed for expansion.

Forms of capital rationing. Prospects are that for the largest number of farmers, capital will long remain the all-important limit to farm size. Limitations on the capital used by the farmer are of two sorts: One is capital rationing imposed by established credit agencies. The credit extended to the operator is based upon and limited by the collateral

which he can furnish. Credit is not often extended beyond 60-75 per cent of the collateral and certainly not beyond 100 per cent. The second type has been termed self-imposed capital rationing. Although this may not be the best suited terminology it is certain that some operators who could borrow funds and expand operations are not willing to do so. This self-imposed limitation or the use of capital was found to be true in a study by Witt (86).

The lack of interest in the use of credit for extending operations stems from several directions. One of these is probably lack of knowledge as to the profitableness of added investment. Another is based upon economic considerations; risks and uncertainties resulting from fluctuations in price and production make some farmers hesitant in borrowing funds. Still another is based upon custom and tradition; children are taught by their parents to avoid debt, to repay contracted debts as soon as possible and that there is a social stigma associated with debt. Too, the farm family may think in terms of the interest and principle payments as additional burdens to family living rather than in terms of the additional returns forthcoming even where the loan is profitable. They sometimes do not differentiate between loans for consumption and production purposes.

Self-imposed capital rationing arising out of price uncertainties may be tied closely to the operator's equity in the capital employed. The smaller is the operator's equity in his business; the greater is the risk that he will lose all in event of a price decline should he borrow additional funds for business expansion. For example, an operator who

has an original equity of only 25 per cent and who borrows an additional amount equal to 25 per cent of all capital employed may lose control of the entire unit if the price level falls by a relatively small amount. In contrast, an operator with an equity of 60 per cent does not take on an equal degree of risk if he borrows an additional 25 per cent.

Form of business organization. Capital rationing which is not self-imposed is undoubtedly the greatest limit to farm size. This limitation to firm size is in contrast to other industries in which the important volume of business is accomplished by corporations. The corporation can draw funds from many households. It can draw greater funds from outside the industry and is not necessarily dependent upon the savings of owners or workers in the organization. In agriculture most of the machinery, semi-finished products and equipment is owned by the families which use them. Accumulation of additional capital must come mainly from the family's income after yearly expense and family living have been provided for.

The predominance of single proprietorships in agriculture means that ordinarily the capital accumulated by one individual is divided among his heirs at the time of his death. Hence, in the typical case, the farm may be operated as two or more distinct units or one heir may buy the shares of others. In either case the process of capital accumulation and the increase in owner's equity must largely start over again. The firm in agriculture is a one generation affair.[1] In contrast, the con-

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[1] The situation in agriculture is paralleled by that of other small scale industries such as grocery stores, filling stations, barber shops and similar lines.

timuity of life for the corporation in other industries more nearly allows an approach to the optimum size or the maintenance of optimum size once it is attained.

Of course the farmer has an opportunity to acquire the use of capital aside from that owned or borrowed. He can rent certain assets, chiefly land and improvements. Involuntary capital rationing is less of a deterent to scale of operations in the case of tenant farmers than in the case of those who desire title to the non-human resources they employ. The operator who chooses to expand extensively through renting additional land is not restricted in the same degree, providing the land is available, as is the individual who wishes to own any additional land operated. However, even the tenant farmer is most often held to a scale of less than optimum size. The amount of land he can operate is tied to the amount of machinery and other such capital which he controls. Certainly, capital rationing limits the scale of livestock production on tenant farms by as much or more than on owned farms.

The rented farm has one additional advantage over the owned farm in respect to size and capital rationing. Not only will a given investment allow the operation of more rented land in cases of creditor-inforced capital rationing but the degree of so-called self-imposed capital rationing may also be less of a deterent. The operator of rented land stands to lose less from fluctuating prices and yields than does the person who invests in the title to the land. Thus he is more often willing to expand his operations to a scale beyond that of the full owner.

Permanence of capital rationing. As long as the single proprietorship is the predominant form of business organization prevailing in agriculture, capital rationing will continue to be a greater force in determining size of operations than will the principle of equal marginal costs and marginal revenue. Contrary to the oft-expressed predictions of the 1920's, the move towards corporate owned and operated farms has shown no wholesale trend. The percentage of farms operated by managers was 1.1 per cent of all farms in 1920 and .6 per cent in 1940 (Table 5). The percentage of land area so operated was somewhat greater in the latter year but still represents an insignificant total as compared to other industries. These managed farms roughly coincide with the group of farms which are owned by corporations, large estates and other absentee landlords. Too, the increase of 1940 over 1920 includes some

Table 5. Per cent of farms and farm lands operated by managers for specified years, United States

Year	Per cent of farms	Per cent of farm land
1900	.9	10.4
1910	.9	6.1
1920	1.1	5.7
1930	.9	6.3
1940	.6	6.3

Source: U.S. Census (80)

lands which are still owned by credit agencies as a result of the 1930's foreclosures. The latter does not necessarily represent a move toward corporate ownership.

The spacial factor and seasonality of operations are probably the reasons that the mass-production corporation has not become important in agriculture. There is not the opportunity to take advantage of the division and simplification of tasks, for the close supervision of large numbers of workers and similar considerations which have lead to the corporate form of business in other industries. This will likely hold as true in the future as in the past. Therefore the limitation of capital will continue to be the all important force determining scale of operations in agriculture.

Mechanization and capital rationing. Finally, the capital complex has as often been the key to farm size adjustments resulting from mechanization as have been changes in cost relationships. The most important mechanical development in agriculture has been the tractor and tractor-drawn equipment. Before adoption of these machines, the typical family has tended to operate at a scale possible in terms of its capital or labor supply. With a somewhat similar capital investment it has been able to substitute tractor power and tractor machinery for horses and horse machinery. The marked change has not been in the total capital investment but the form of the capital employed. However, the similar capital investment has made possible greater scale operations with the previous or a smaller amount of labor. The family has tended to expand

operations not so much because fixed costs are thus lowered but because a given labor supply can now handle a greater volume of business. Yet before the family can expand operations, it must wait until nearby land is available. Land will be available if some other operators move to other occupations in the manner suggested in a preceding section of this study.

Institutional and miscellaneous factors

Certain other factors have an immeasurable effect on farm size. These factors mainly impede the adjustment in scale of operations toward the optimum. Further, they partially nullify the potentialities of expansion which are opened through mechanization or other developments.

Household aspects. Included in the group of forces which limits scale of operations is family size. Agriculture more than any other industry of such import is a family affair. United States Department of Agriculture figures (79) show that for the three periods 1910-19, 1920-29 and 1930-39, family workers constituted 76, 75 and 77 per cent respectively of all workers employed on farms. The size of the family in agriculture, as elsewhere in the economy, has been on the decline over the past several decades. As long as the production unit in agriculture leans heavily upon the farm family for labor, the possibility of increasing the size of the unit through the adoption of labor-saving equipment is partially offset by the smaller number of workers per family. An even more important force of this nature has been the increasing migration

(depressions excepted) of farm-reared children to towns and cities, which has been suggested in such studies as that of Baker (4). In many cases a tractor has been employed as one member of the family left the farm or if a tractor was already in use, larger capacity tillage and planting equipment has been employed.

That the size of many farms would be greater if additional family labor were available is suggested in the Iowa study previously cited. Fifty-two per cent of the farmers in the lower one-third of the income bracket indicated that lack of labor was a factor limiting size. Thirty-two per cent of those falling in the upper two-thirds so indicated. Obviously, these farmers were referring mainly to family labor, since an ample supply of hired labor was available in the year of the study. These farmers either did not have the capital or were unwilling to pay out funds for hired labor else they would have done so. Yet had the family labor been available at little or no cost, it would have been used in expanding scale of operations.

There are also other factors tied quite closely to the farm family and which impede farm size adjustments. The fact that the farm is not only a business firm but is also the family home is not considered in the theory of the firm. The cords of sentiment often tie the farm owner to his land even though his net returns for the existing unit are less than for other alternatives and in spite of the fact that he can't adjust to the optimum scale. The farm is his home. It represents the reward for his toil and that of his family. A change to other types of work

means leaving the hard-won home. This is not so true in other industries where it is possible for the laborer to change jobs without moving his home.[1] As long as farm operators thus cling to inadequate units the decline in numbers and consequent consolidation and expansion of other units is prevented.

Uncertainty. Another factor which may restrict farm size to less than the optimum is uncertainty. This factor has already been discussed and needs little, if any, qualification from that set out in other parts of this section. An Iowa study (43) indicated that 15 per cent of all farmers included in the study refrained from expanding operations because they were "uncertain" as to the future. The term "uncertain" was not explained and is thus rather nebulous. It might have included uncertainty in respect to personal health, weather, wars, strikes, prices and any number of other factors.

Discontinuity in supply of factors. Another resistance to farm size expansion is to be found in the discontinuity of certain production factors. This is partially true in the case of such capital as the farm tractor. A farm operator who is using his present power and equipment to full capacity may feel that it would pay him to farm an additional twenty or forty acres were it possible for him to combine other factors proper-

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[1]Again the case of agriculture is somewhat paralleled in such small scale industries where the production plant is also the home. Such cases in which the home may be combined with the unit sometimes holds in the case of tailor shops, grocery stores and others. However, the number of such instances is much less frequent than in agriculture.

tionately. Yet the addition of a small amount of land might necessitate the addition of an entire tractor thus making the cost prohibitive.

The problem can be partially solved in the case of power and machinery, however, through the use of smaller-type tractors and the availability of custom work. This is not so true for other factors in which the discontinuity is of another nature. The supply of land available to the operator typically comes in multiples or fractions of quarter sections. Aside from urban regions, areas settled early in the history of the nation and other scattered exceptions, land ownership is transferred only infrequently in parcels of less than 40 acres in the major areas of the United States. More often the minimum unit is 80 or even 160 acres. This situation stems from numerous factors. Policy in respect to mensuration and disposal of public lands by the federal government established a precedent to which private owners have rather rigidly adhered in transfers. The employment of the square mile and quarters thereof as the standard units of measurement was one force in this direction. Another was the offering of tracts in the same multiples for direct sale, military grants, homestead claims, and other methods of disposal. The development of roads along section lines was still another. These policies not only set up a customary pattern for the unit sale of land but also established a pattern of farm size, especially for a span of years immediately following such policies.

Were it possible to acquire additional land in parcels of convenient size and shape many relatively small owned-farms would probably expand operations. For example, many operators of 40, 80, 120 or even 160

acres may have the labor, equipment and capital to take on another 10, 20 or 30 acres. Yet the traditional unit of division means that farms will not be sold in such fractions as long as buyers which will take the entire unit are available. Too, the immobility of land tends to hamper the division of an 80, for example, into units of 10-30 acres each. It would be a coincidence if several bordering farms each should wish such small units. Furthermore, were it impossible to sell one or two such units to farms neighboring the tract it would be increasingly difficult to sell to other owners more distant. The buyer might well refuse to purchase this small unit unless it were immediately joined with his own farm and also stretched the entire length or breadth of his present holdings. But present institutional factors are such that land is not customarily sold in such small units and even where such is true the tract most often is across the road from the farm and of such dimensions that fencing and operational costs are high.

The tenant farmer is similarly prevented from expanding his operations by small increments where such is both possible and profitable in light of present supplies of labor, equipment and capital. The owner of land prefers to rent a tract of reasonable size as a unit rather than to bother with the additional supervision, fencing costs and similar considerations which are encountered for a number of small subdivisions. The investment sunk in buildings also accentuates the tendency to rent farms as a whole. As long as the demand for farms by tenants is sufficiently great, the landlord can ordinarily realize some amount of cash return on

this investment which would be impossible if the land were subdivided and the buildings left idle. Again, the immobility of land serves as a hindrance to the operator who would be willing to rent a nearby parcel but who is unwilling to stand the relatively higher costs coincident with operating a small unit which may be remotely available. These several considerations serve to partially arrest the tendency to consolidate units and expand scale of operations. This is especially true in areas in which crops represent an important portion of the farm business.

Tenancy. Another institutional factor acting as an obstacle to a greater scale of operations hinges around tenure. Length of tenure is especially important in preventing an expansion through intensification of operations. Schickele and Himmel (63) found that the type of lease and length of occupancy affect the farm organization. The crop share lease, specifying only one year's occupancy, definitely discourages the development of livestock enterprises. The tenant especially refrains from expanding operations which will require a fixed investment as long as no provision exists for unexhausted resources. He even withholds investment from small equipment or breeding stock which will not turn over completely within the year. A move would require either the liquidation or the expense of moving these items. True, he may still be on the place at the end of another five years, but at the time of planning one year's operations he never knows when or how far he will have to move in the future. His operations are thus held at a scale of less than optimum or that possible in light of his capital and labor supply.

There are other miscellaneous forces which impede the adjustment of farm size in the direction of the optimum scale.[1] Such cases as these are less important, both numerically and otherwise, than the other impediments which have been mentioned.

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[1] Some persons might suggest that management is a limiting factor since some operators have expanded as far as is profitable in light of their managerial ability. Such operators can, however, be considered as having attained the optimum size and need not be included in a discussion of forces which impede adjustments to the optimum scale.

HISTORY AND PATTERN OF FARM SIZE CHANGE IN IOWA

Much interest has centered around the consolidation of farms in Iowa. Unofficial estimates have often placed the number of consolidations at a high level. Some have expressed the opinion that an unduly large number of families are being forced off of farms as a result of the increase in the acreage of some units. It has also been implied that acreage adjustment is a recent phenomenon resulting from mechanization and that rapid increases in the acreage per farm will continue.

But what have actually been the trends? Has the number of consolidations been as great as is commonly supposed? Is the adjustment in farm size only a recent development? If not, how do present trends compare with those of the past? What are the chief causes of farm acreage adjustments in Iowa? What factors have been important in molding farm size? What farms have been increasing in size; is it the small unit which has been expanding in acreage or is it the farm which is already large?

In order that some objective answers to these and related questions be provided, this section on the history and pattern of farm size in Iowa has been included in this study. It represents an attempt to trace and analyze recent changes. It also traces historic developments in farm size adjustments. Although the first of these is of the greater current concern, a study of the latter makes possible a better understanding of (1) long-run trends in farm size, (2) the many forces motivating farm size

adjustments and (3) the various forces molding the pattern of farm size. Knowledge of these is especially necessary if the mistake of over-emphasizing one or a few forces is to be avoided.

Obviously, the most meaningful measure of size for the analysis of these problems is acres. This is only one measure of farm size, yet it is the crucial measure in this case. The number of farms and farm families which can exist at any one time depends on the average number of acres per farm.

Source of Data

The data upon which this section is based were taken from the United States census. These are practically the only data available for the examination of long-run trends. Of course one might take random samples in the state which would give the extent of farm consolidation for one or a few years, depending on how far back present operators could remember the number and extent of consolidations in the neighborhood. Although a study of this nature gives a great deal of detailed information on the consolidations in any one year, the survey is not only a sample of farms within the geographic area under consideration but also only one sample over time.[1] Thus it does not allow the analysis of long-run trends.

There are certain objections to the use of census data in studies dealing with numbers of farms or the average acreage per farm. The most serious objection has to do with the definition of a farm and the inclusion

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[1] The decennial census is only a sample in time but enough of these are available to make possible some indication of trends.

(or exclusion) of those farms on the borderline of the criterion employed. This complexity is greatest for comparisons between the regular decennial census and the intervening five-year census. It is quite evident that the two have not been comparable on the basis of the number of small units included. Although the definition of a farm used has been the same, the five-year census seems to include certain small farms that are not included in the decennial census. There are several reasons why this is so. In the first place, the amount of funds available for the five-year census necessitates a less accurate enumeration. However, the most important reason is probably this. In the regular decennial census a population schedule is used along with the farm schedule. This requires that the enumerator visit all families. If the family qualifies as a farm family he then fills in the agricultural schedule. Since all families are to be included the incentive to manipulate the number and location of schedules taken is less than for the five-year census. The five-year census includes only farm families. The enumerator, basing his action on his own observation as to which are and which are not farms, may not go near farms which are included in the ten-year census. However, the opposite is probably more common in such states as Iowa. The enumerator for the five-year census obtains schedules for units which are not included as farms in the decennial census. This tends to be true since there is no check against a population schedule and since it is easier and more profitable for the enumerator to include a large number of very small units on the outskirts of cities and towns even though these units may

not actually come under the definition of a farm. Too, there may be some small tendency for the enumerator of the five-year census to exclude a few large units which are more distant from towns since it is not necessary that these farms be visited for a population schedule.

For these reasons only a small amount of use has been made of the five-year census in this study. It is of course true that some differences may exist even between the different years in the regular decennial census. The farm which was classified as a farm in 1920, for example, may not have been included in 1930 even though it is exactly identical in size and physical production. Too, when consolidation of farms is being considered, the census definition brings forth another difficulty. For census purposes a tract is defined as a farm if it includes three or more acres of land or if its agricultural production for the census year amounted to $250 or more. This definition leads to complexities in the case of operators who retire on farms. For example, suppose an elderly operator who has been operating 160 acres retires on the farm by retaining the use of the buildings and lots. Five acres are included in the farmstead. According to the census definition the farmstead may be included as a farm even though an insignificant amount of production is carried on. If this operator rents the remaining 155 acres to a neighbor who also operates 160 acres the average size of farm will be the same as before the consolidation. Before the consolidation two farms of 160 acres existed and the average for the two farms was actually 160 acres. After the consolidation and according to the census definition, two farms still

exist--one of 5 acres and one of 315 acres. The average is still considered as 160 acres.

Thus the main weakness in the use of census data rests on the definition of a farm. Lack of reliability falls mainly in those size groups in which any question exists as to whether or not the unit is actually a farm. Lack of reliability falls mainly in those size groups in which any question exists as to whether or not the unit is actually a farm. Some small amount of error may also hold in the larger size groups but it is hardly possible that these are great enough to obscure any trends in farm size.

In order to get around the errors resulting from the definition of a farm, the conclusions of this study are based, wherever such is possible, upon the distribution of farms by size as well as on the average acreage per farm. Further, the use of farm size distributions allows the exclusion of those groups in which there may be some doubt as to the definition of a farm. In Iowa exclusion of the farms of nineteen acres or less should remove most of this difficulty. Most units of twenty acres and over could undoubtedly be classified as farms since the problem of estates which include a large number of acres but which are not farms is unimportant in Iowa. Too, any farmstead which includes as much as twenty acres will, with few if any exceptions, be part of a bona fide farm. There are very few farms of less than twenty acres which are agriculturally important in the state. Some few highly specialized small units do exist. However, these units are not important when problems of consolidation are being considered. The return to the operator of such units is mostly

attributable to labor or capital and hence competition with large operators on a basis of rents is hardly effective. Further, the regular commercial farmer who wishes to expand his operations does not go out searching for a five, ten or even a nineteen acre plot. True trends in farm consolidations can even be spotted in the size range of fifty acres and over if they are actually taking place. For the above reasons the size group 9-19 acres has been excluded from the distributions in this section. Distributions which include this size group are included in the appendix. In no case would the main conclusions of this study have been altered by substituting the distribution which includes the 9-19 acre group for the one that does not.

Data on the distributions of farms by size groups were not available for the early years in the history of the state. However, since the trends for the early period are so pronounced the figures on average size can be used with confidence. All data presented in the tables as figures of this section are either taken directly or derived from census data unless otherwise indicated.

History of Farm Size

The initial pattern of farm size in Iowa, as in other midwest and western states, was largely established by the nature of early land settlement and land disposal policies and by the fact that the standard used for dividing the land area was the 640 acre section. In fact, a first stage in pattern of farm size was established in Iowa even before the disposal of the public domain began. Although surveying of the

Half-Breed Tract (the triangular part of Lee county) was completed in March of 1832, the general survey of public lands in Iowa did not begin until the autumn of 1836. Actually, "squatters" often preceded the running of survey lines and the marking of corners. Settlement of the Black Hawk Purchase began as soon as Indian occupancy was terminated on June 1, 1833, even though the survey was not started until 3 years later.

Settlers' claims

Over ten thousand persons were living in Iowa by 1836 when the survey of the Black Hawk Purchase was initiated (46). These "squatters" were, in the interpretation of a congressional act of 1807, trespassers upon the public domain. They did not own their claims and had no legal rights to their holdings. Accordingly, they might have staked out a claim of any size whatsoever. Their legal rights were no greater or no less for a large claim than for one of medium or small size. Yet a definite pattern of farm size existed even at that pioneer time.

The typical claim was apparently one of 320 acres according to Lokken's (45) description of squatters' land measurement. The absence of section lines was no obstacle to the pioneers. They used the sun at noon and evening as a guide in establishing claim lines and counted off so many steps each way for 320 acres, the area of a claim. It was recognized that these lines were far from correct but it was understood among squatters that these inequalities would be rectified once the lands were surveyed and entered. A section line through a claim would mean that the area lost on one side would be offset by that gained on the other.

That the typical claim of the first settlers was 320 acres if also substantiated elsewhere. Taylor (72) quotes a claim association of Marion county as follows:[1]

> Whereas, it has become a custom in the western states, as soon as the Indian title to the public lands has been extinguished by the general government, for the citizens of the United States to settle upon and improve said lands, and heretofore, the improvement and claim of the settler, to the extent of three hundred and twenty acres, has been respected by both the citizens and laws of Iowa....Resolved, that we will protect all citizens upon the public lands, in the peaceable possession of their claims, to the extent of three hundred and twenty acres, for two years after the land sales, and longer if necessary.

According to Donnel (20) a provision of the Jefferson County Claim Association stated that any person twenty-one years old, or any other person at the head of a family could "possess him or herself of three hundred and twenty acres belonging to the government, and not legally claimed by other persons". Shambough (66) indicates that the Johnson County Claim Association allowed each settler to stake out a claim of 480 acres.

The most common maximum seems to have been 320 acres. Of course some claims of less than the maximum size allowed by the "squatters'"

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[1] A claim association was an organization established by the "squatters" to protect the individual's interest in the claim which he had staked out. The "squatters" had no legal right to their claims and any outsider had legal authority to buy the land which had been set up as a claim. By group action the claim associations were able to minimize such proceedings. In some cases where an outsider took over a claim, the association drove him away by numerous thrashings, by burning his cabin and by similar practices.

unofficial laws were staked. However, as would be expected, each settler tended to stake off the maximum. Thus the average size of farms was larger during the period of infancy in the state's agricultural development than for any subsequent period. Even if today's definitions were to be used as the measuring stick, the "squatter's" claim was not a family-sized unit. It was greater than family size in terms of labor requirements. The family could not possibly hope to stock and till the entire unit. Too, it was not a family-sized unit in terms of the "squatter's" customary standard of income. He was able to cultivate and live from only a fraction of the claim. The remainder was left idle or was utilized only very extensively. Several additional families might have eked a similar real income from the same 320 acres.

The pioneer farmer took over such a large unit not because he expected to cultivate a major portion of it but because of his hope of gain. He was undoubtedly aware of the appreciation of land values which took place in other states as they were settled. Thus the large unit not only gave the pioneer farmer and his family a home and a tract of land from which they might earn their livelihood but it was also a potential capital gain should the area become thickly settled. Some probably expected that, although cultivation and stocking of the entire unit was impossible at the outset, they might accumulate enough capital to buy the tools and hire the labor for the cultivation of a large acreage or to purchase the livestock for grazing, a less intensive type of farming.

He probably did not take more for several reasons. As already suggested, even 320 acres was more than he could hope to cultivate.

Selection of full sections would have resulted in a very widely scattered community. More could hardly be justified in cases where a large number wished to settle in a limited area. Too, the pioneer probably realized that the possibility of his being able to purchase 320 acres or that the government might turn as much over to him for settling the land was only wishful thinking.

But why did the "squatter" select exactly 320 acres? Why did he not select, for example, 300 acres or 350 acres, since the difference is not very great? The reason that exactly 320 acres instead of some other amount was selected probably rests on the fact that the standard unit of measurement employed in surveying the public domain was 640 acres. The 640 acre section was too much land for the "squatter" so he simply took one-half or 320 acres. Had the public domain been laid off in blocks of other sizes it is entirely possible that the modal farm size would not have been exactly 320 acres. For example, if the public domain had been divided into units of 800 acres each the "squatter" might have taken one-half of this or 400 acres. Or, if it had been measured off in units of 600 acres the typical "squatter" unit might have been 300 acres. Thus the individual who originally devised the 640 standard for dividing the public domain established a powerful precedent for farm size. This was true not only for the initial pattern of farm size in the state but also for subsequent developments. For example, it was only natural to divide the 640 acre unit into two of 320 acres, the 320 acre unit into two of 160, the 160 acre unit into two of 80 and the 80 acre unit into two of 40 acres.

Had the original unit been 600 acres the sequence of division might have been two 300's, two 150's, two 75's or three 50's. Had the original unit been 800 acres the sequence might have been two 400's, two 200's, two 100's and two 50's.

Public land disposal policy

A new pattern of farm size followed close upon the heels of that of the first "squatters". This next stage in the pattern of farm size more nearly revolved around public land disposal policy. The first sale of public lands in Iowa was held at Dubuque in 1838. However, Congress enacted measures in each of the years 1830, 1832 and 1834 which gave the "squatter" preemption rights to his claim in case the land had been surveyed. Under these acts any settler who had occupied and cultivated a quarter section during the preceding year was authorized to buy the same at the minimum price of $1.25 per acre. The acts of each of these years only legalized claims already established; they did not grant preemption rights to future "squatters". Furthermore, the acts of the first few years meant little to Iowa settlers since survey of the Black Hawk Purchase was not completed until 1837 (46). However, the settlers now had some assurance that they would eventually be able to buy their homes at reasonable terms; they might at least expect subsequent acts which would make them eligible once the surveys were completed.

The fact that the maximum to be expected under preemption rights was 160 acres should have forced a trend toward claims of this size rather than the former customary claim of 320 acres. Once the right of preemption could be exercised after the annual acts of 1838 and 1840 and

the more permanent act of 1841, the modal farm size became 160 acres. Any individual could now enter his claim before the land went on sale. Preemption claims were again limited to 160 acres and in addition no person could own more than one claim; nor was any person eligible who owned 320 acres in any other state or territory.

Many settlers were unable to scrape together the necessary funds to enter their claims before the public land sales and any person had legal right to bid on land for which preemption rights had not been exercised. Thus it might seem that large holdings might have been acquired once public sales were held. This was true to some extent. Yet the typical unit sold to settlers was still the quarter section. Lokken (46) describes the settlers' unofficial laws which protected the interests of the "squatter" at the land sales and allowed him to buy his 160 acre claim at the minimum even if he had not exercised preemption rights but was now financially able to bid the $1.25 per acre. The settlers, summarily punishing outsiders who bid on claims, were able to minimize such "unscrupulous practices" and safeguard the "squatter's" claim to 160 acres.

Land was apparently auctioned in these minimum units with few exceptions. On the other hand, the "squatter" could not often acquire more than $200, the minimum price of 160 acres. Even then a large portion of the purchase price was borrowed at exhorbitant interest rates.

Were it possible to show a frequency distribution of farms by size for this period of early land ownership in Iowa, the distribution undoubtedly would be skewed to the left. Whereas the quarter section was the modal-sized unit it was also practically the minimum. On the other hand the

number of farms over 160 acres was greater than the number of those less than this size. It is reported that some small speculator-farmers bought land for speculative purposes (46). Too, some persons who were not speculators and whose intentions were purely agrarian had the funds for more than 160 acres.

Even after the first preemption rights and public land sales land disposal policy continued to mold the pattern of farm size for some years. Disposal of the public domain by means of military warrants began under the act of 1847. Under this act certain qualified soldiers from the Mexican War or their heirs were to receive a bounty of 160 acres of land provided these veterans had served in the volunteer army for twelve months or had been discharged for sickness or wounds. This act also provided land warrants of forty acres for those who had served less than twelve months. An act of 1850 granted eighty acre warrants for services in any Indian war since 1790, the war of 1812 and to commissioned officers in the war with Mexico. An act of 1852 made land grants assignable while an act of 1855 provided for 120 acre, 100 acre, 60 acre and 10 acre warrants and extended the bounty land privilege to thirty-two classes of persons within the army, navy and other services (46). Evidently these smaller grants represented a means of bringing all land bounties up to 160 acres since the latter act made 160 acres the minimum and provided additional grants to make up the total for those who had received less. Some of the grants were actually utilized by veterans who wished to settle upon the land. Probably a greater number of the warrants were purchased by others who wished to farm. A relatively large number were also purchased by persons who aspired to hold the land for speculative purposes.

Thus the early pattern of farm size was maintained; the typical unit remained at 160 acres while the average remained greater than a quarter section due to the larger land holdings of speculators and others where the units were organized as farms. This latter fact is expressed in Table 6 which shows that the average size of farm was 185 acres in 1850. Additional methods of land disposal tended to perpetuate this pattern. Still other less important grants probably helped break the precedent of 160 acre minimum units.

Secondary disposal agencies and other forces

The average farm size diminished by twenty acres from 1850 to 1860 and by thirty-one acres from 1860 to 1870 according to census data. This relatively sharp decline in average farm size was the result of several factors. Important factors include: (1) nature of land transfers and transferring agents, (2) business conditions and (3) maturing of the pioneer economy.

By 1865 only four and one-half of the original thirty-six million acres remained as public domain in Iowa. By 1870 the federal government held only about one million acres. Much of the non-federally owned land, however, was not included in farms. Census figures show only ten million acres in farms for 1860 and only fifteen and one-half million in 1870. Much of this land was still held by the state through such grants as the sixteenth- section grant, the five-hundred-thousand acre grant, the university grant, the agricultural college grants, the saline grant and the swamp-land grants. Some land was already held by the railroads.

A relatively large acreage was held by speculators who had procured ownership through purchase of military warrants or otherwise.

Table 6. Land in farms, number of farms and average acres per farm, Iowa census years 1850-1940

Year	Total land in farms (000's)	Number of farms	Average acres per farm
1850	2,736	14,805	184.8
1860	10,070	61,163	164.6
1870	15,542	116,202	133.6
1880	24,753	185,351	133.5
1890	30,492	201,903	151.0
1900	34,574	228,622	151.2
1910	33,931	217,044	156.3
1920	33,478	213,439	156.8
1930	34,019	214,928	158.3
1940	34,149	213,318	160.1

Although the quarter section was practically the universal unit by which bona fide farmers acquired ownership under purchase from the federal government, this apparently was less true for land sold by the state, railroads or speculators. The latter group of land holders either desired maximum profits or wished to see the state settled at an early date. It is to be expected that they would sell land in units of less than 160 acres whenever such promised to further their ends.

Investigation substantiates this belief. By 1853 the state had sold 253,472 acres of the Des Moines River grant in small parcels and to actual settlers (60). Leases with option to purchase the agricultural college grant were initiated in 1865. The maximum amount leased to each

person at the outset was 160 acres. Paulson (60) indicates that early sales of school land were invariably made to actual settlers and in small units. Howard county swamp lands were sold chiefly from 1869 to 1875 and in units of forty acres each.

Railroad lands, which were sold somewhat later, were transferred to actual farmers in small units. Hibbard (32) states that the parcels sold by the Burlington and Missouri River Railroad Company averaged 130 acres in Iowa and Nebraska. Sales of land made by the Iowa Railroad Company in the state averaged approximately eighty acres (60).[1]

Data on sales by speculators is not available. However the fact that this group of land holders bought up large tracts and held them until most of the free land was taken in the early-settled parts of the state suggests that the sales were in small units rather than the traditional quarter section of the federal government. Speculators bought and held such land for increasing values. The 140 largest purchases made by means of military scrip totalled 1,381,000 acres and averaged 9,860 each. One single purchase was for 200,000 acres. The 54 largest cash purchases totaled 752,555 acres, an average of 13,936 each. One large tract, purchased partly in script and partly in cash, totaled 344,578 acres (32). These holdings were not considered as land in farms and most large speculators had liquidated their holdings to settlers by 1863. Their

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[1] It is possible that these sales included some units laid out as town sites and thus the average figures would be less than if only farm lands were included. However, there is ample evidence that sales of farm units averaged less than for the sales by the federal government.

lust for profits resulted in sales of 120, 80 or even 40 acre tracts to settlers who had only a limited amount of capital.

The traditional minimum unit of 160 acres was thus partially removed in favor of smaller purchases. A large number of 160 acre farms still existed but the addition of a large number of smaller farms meant a decrease in the average farm size.

In addition to the fact that land could be purchased in smaller units, more persons were now willing to accept less. The fact that the bulk of the public domain, and especially the more desirable land, has passed into the hands of private individuals or the state government increased the willingness of new operators to be content with less than 160 acres. Previously there had been little need to accept less than 160 acres since this amount was readily available in the vicinity as a part of the public domain. As the public domain dwindled, however, it became necessary to search farther and farther for desirable tracts. Thus, the person wishing to settle in the vicinity of friends or relatives was more content to buy an 80 or 120 acre unit than when the traditional quarter section could be obtained only a few miles distant at the minimum price of $1.25 per acre.

That depressions are accompanied by farm size adjustments is apparent when one examines recent economic phenomenon. Certainly this must have been a factor of some importance affecting the decline of farm size from 1850 to 1870. The depression which started in 1857, while short-lived, was extremely sharp and land values dropped from $10 to $2 and $4 per acre.(32). These depressions especially burdened pioneer farmers. Many had purchased

farms with money borrowed at extremely high interest rates. At one time after the 1857 crash one-half the land in Hamilton county was advertised for the tax sale. Taxes were delinquent for 2 and 3 years on most land so advertised (52). Some farmers were thus forced to sell portions of their farms in order to retain the rest. Too, lack of funds limited the number of acres which the newly-arrived settler could purchase and, in contrast to the major period of public domain liquidation, it was now more nearly possible for him to buy in units of less than 160 acres. That a large portion of this decline in farm size resulted from a division of existing units as well as from the advent of newly-improved but smaller units is suggested in Table 6.[1] The number of farms increased by 90 per cent while the acreage in farms increased by only 54 per cent in the period 1860-70.

One stage in the maturity of the pioneer economy, apart from depressions, also tended toward division of existing units in the period 1850-70. Some farms had apparently been of greater than optimum size previous to 1850. Certainly one family could not often improve and cultivate a full quarter section previous to this time. The crude tools of the period did not allow it. Likewise, lack of capital prevented many from fully stocking the non-cultivated portion of the farm. The quarter section as a whole was indeed farmed extensively. Yet as long as nearby lands

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[1]Had the decrease been the result of newly-improved units alone, these new units would have averaged only 99 acres per farm. Newly-created farms under the homestead act of 1861 were set at 160 acres each.

could be used for the mere "squatting" there was little chance to dispose of the surplus. However, once the "free" lands were exhausted in the early settled regions the increased demand and consequent increase in land values made possible the division of some units at a profit. Farmers who disposed of the "unutilized" portions of their farms might thus acquire the resources for a more intensive and more profitable operation of the remaining unit. Such a division of existing units would obviously result in a greater percentage of cultivated land. That this division and more intensive cultivation of existing farms took place tends to be substantiated by census figures. During the period 1860-70 the area of improved land in the state increased by 150 per cent as compared to the 54 per cent increase in total farm acres.

The period 1870-80 brought practically no change in average farm size. It seems to have represented a turning point in the trend of farm size. The average acreage per farm veered upward by eighteen acres from 1880 to 1890 and although the data on the numbers of farms by size distribution is meager, that which is available also points in this direction.

As a whole the period 1880-90 was one of prosperity. Although the year 1885 resulted in prices so low that some corn was burned as fuel, farmers had passed through a prosperous period in the early 80's and prices made some recovery after 1886. The further maturing of the economy was, however, probably more important in bringing about the increase in farm size. The new stage in the maturity of the economy, in contrast to the earlier stage mentioned, tended toward larger farms for

numerous reasons. Agriculture had now passed through its infancy and some farmers had accumulated enough capital that they might add to their holdings. The agriculture of the state had now proven itself and risk was no longer as great a hindrance to the flow of capital into the state from outside.

The increase in average size during this period might conceivably have resulted from two different methods: (1) through newly-created large units, and (2) by the consolidation of existing units. It appears, on the basis of census data, that the latter was the more important force. A large amount of land held by railroads was still being sold during these periods. However, while the railroads sold some large units the greater number of tracts were of around 100 acres. For example, the Iowa Railroad Land Company's sales average 77, 104, 112, 110, 93 and 81 acres in each of the years 1880-85 inclusive (32). On the other hand, consolidation between 1880 and 1890 is indicated in Table 7. The number of farms falling in the group 20-99 acres decreased from 82,007 to 71,763 or from 46 per cent of all farms over 19 acres to 37 per cent. This is in contrast to the 9 per cent increase in the number of all farms over 19 acres and an increase of 35 per cent in the number of farms over 499 acres.

Equilibrium tendencies 1890-1920

The next thirty-year period, 1890-1920, was one of stability in respect to the average size of farms. The average for all farms increased by 5.8 acres from 1890 to 1920. Both the number or farms and the

acreage of land in farms increased during this period. On the basis of census figures the additional land in farms per added farm average 155 acres between the two years. Thus the creation of new farms would have had little effect on the average size of farms.

However, some shift in the distribution of farms by size groups did take place (Tables 7 and 8). There was a definite trend toward more medium-sized or family-type farms and away from small and large units. The number of farms falling in the range 20-99 acres decreased in each of the ten years of the decennial census and was 22,687 fewer in 1920 than in 1890. The number in the range 500 acres and over decreased by 1,472 or by 44 per cent. The number in the range 260-499 acres decreased although comparisons cannot be made between each of the ten years from 1890 to 1920. Conversely, the number and the percentage of farms falling in the group 100-259 acres made a marked increase. It appears that an equilibrium in size pattern might have followed the adjustment which took place between 1890 and 1920 had not other forces set in. However, around 1920 the adjustment seems to have taken on another nature as will be pointed out later.

The pattern of farm size change which took place between 1890 and 1920 paralleled the relative maturity and stability of the agricultural economy during this period. The maturity of the period became felt in various ways. Land disposal policies no longer had direct bearing on size changes after 1890. The land was fully settled by 1900. Some of the adjustments between size groups probably represented the aftermath

of previous disposal policies. Some units resulting from purchases from railroads and other secondary disposal agencies were probably too small: Expansion was possible as capital was accumulated by some small-scale operators. More favorable income opportunities opened up elsewhere as industrialization of the nation continued. Other farms were too large. A more intensive agriculture developed, thus limiting the acreage that could be tilled by the family with the then current techniques. The townward migration of farm-raised children diminished the family labor supply. Perhaps some farms had even been established on a scale too large for maximum return under the methods of the period. Land was now passing into the second and third generations of owners. Some large holdings were thus divided among heirs and were not recombined since, due to the increase in land values, one heir could not often buy a large unit. Too, industrial and technological development seemed to favor the investment of speculative funds in other than large-scale farm units. Finally, a maturing agricultural economy and exhaustion of public lands resulted in an increased demand for tenant-operated farms and in turn enhanced the possibilities of dividing large units.

The period 1890-1920 was not entirely free from major economic change but it was comparatively calm as compared to preceding and subsequent periods. There were no startling technological changes. Tractors, cornpickers and other labor-saving machines were invented but had not yet been improved to the point where they were widely adopted. No improve-

ments comparable in effect to hybrid corn and recently improved oat and soybean varieties were developed.[1] Complications arising out of foreign trade were mainly felt after the period.

Table 7. Number of farms of over 20 acres by size distribution in Iowa, census years 1880-1940

Size groups in acres	1880	1890	1900	1910	1920	1930	1940
20- 49	23,488	18,418	21,475	15,678	13,117	12,178	12,003
50- 99	58,519	53,345	49,685	38,712	35,959	32,209	32,146
100-174	a	a	a	80,121	85,549	84,722	82,393
175-259	95,163	121,003[b]	142,678[b]	40,304	41,414	42,615	41,452
260-499	a	a	a	25,861	25,865	25,546	26,119
500 & over	2,662	3,586	3,158	2,644	2,014	2,136	2,583
All farms over 19 acres	179,832	196,352	216,974	203,320	201,918	199,406	196,696
All farms over 49 acres	156,344	177,934	195,499	187,642	188,791	187,228	184,693

[a] Data not available.

[b] 100-499 inclusive.

Although there were short-lived business recessions and scattered droughts during the period, the severity of these was certainly at a min-

[1] It is true that experimentation had developed some improvements in breeds, varieties and in husbandry in general, yet none had such sudden impacts on production as the examples cited.

imum as compared to any other similar period since 1853. As a whole, farming was profitable throughout the period. This comparative economic stability and minimum of sudden change was also a favorable environment for an approaching equilibrium and for the pattern of farm size change as outlined above.

Actually the biggest shift in farm size during the period was away from very small farms and toward units of medium size. Had the division of large farms been as frequent as the consolidation of small farms the total number of farms would have changed but little during the period. However, as can be seen in Table 7, there was a net consolidation of 15,056 for all farms over twenty acres from 1900 to 1920. Similarly, the number of farms over forty-nine acres decreased by 6,708. Thus the greatest consolidation seems to have been for farms in the 50-99 size group since

Table 8. Per cent distribution of farms over 20 acres in size, Iowa Census years 1880-1940

Size in acres	1880	1890	1900	1910	1920	1930	1940
20- 49	13.1	9.4	9.9	7.7	6.5	6.1	6.1
50- 99	32.5	27.2	22.9	19.0	17.8	16.1	16.3
100-174	[a]	[a]	[a]	39.5	42.4	42.5	41.9
175-259	52.9[b]	61.6[b]	65.7[b]	19.8	20.5	21.4	21.1
260-499	[a]	[a]	[a]	12.7	11.8	12.8	13.3
500 & over	1.5	1.8	1.5	1.3	1.0	1.1	1.3
All farms	100.0	100.0	100.0	100.0	100.0	100.0	100.0

[a] No data available.

[b] 100-499 inclusive.

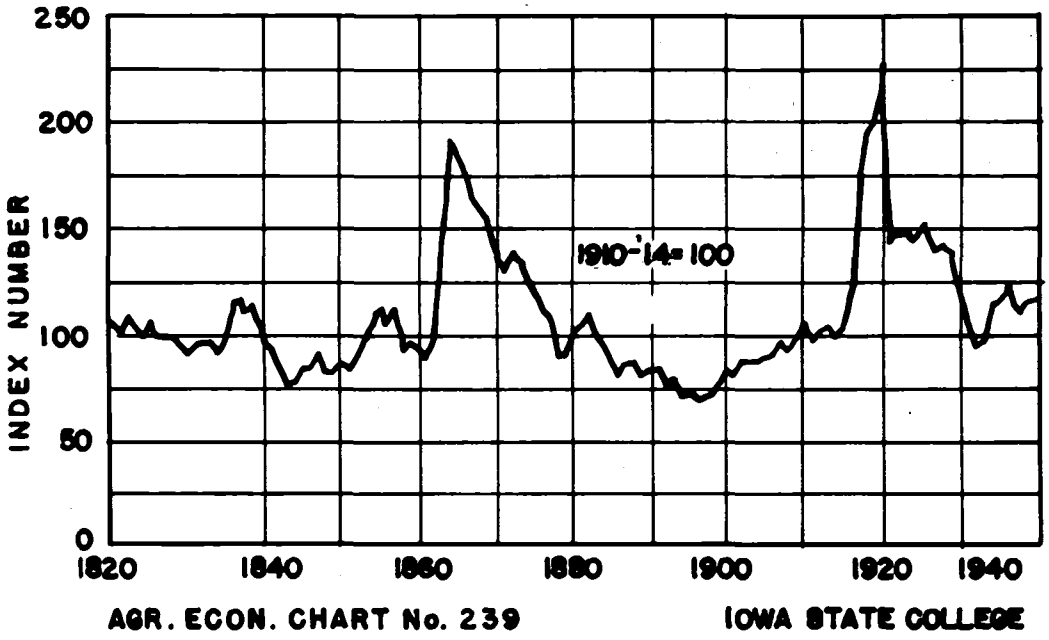


Figure 4. Index of wholesale prices, United States, 1820-1940.

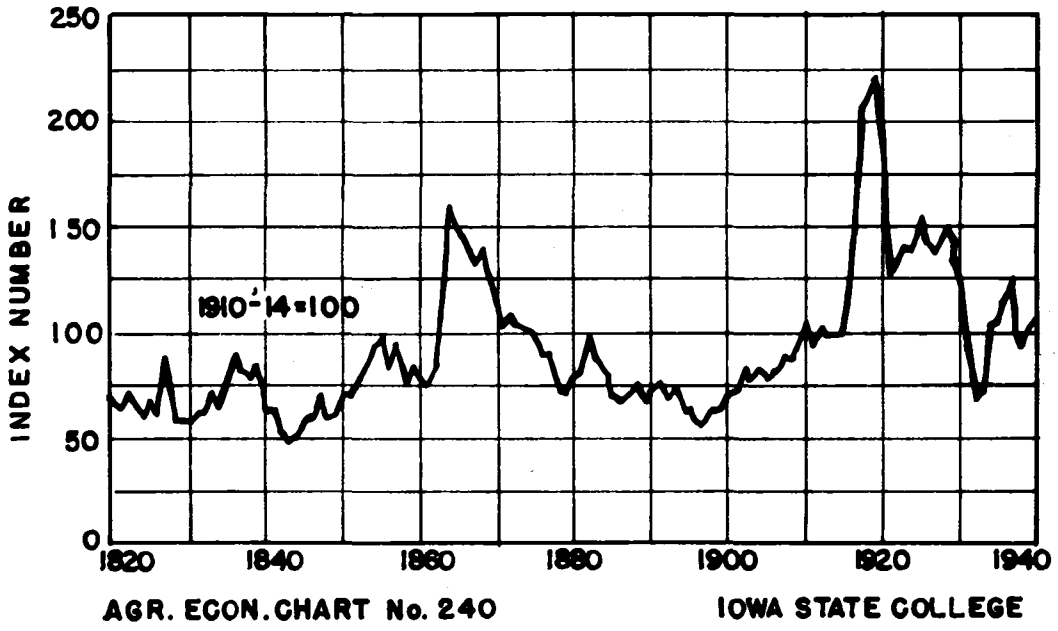


Figure 5. Index of farm prices, United States, 1920-1940.

the number of farms in each of the next two higher size groups increased. If the consolidation of a medium and small farm had been most frequent then the total number of those in the medium size groups would have decreased while the number in the large size groups would have increased.

The temporary increase in numbers of very small farms between 1890 and 1900 probably resulted from two or three factors. It may have been partly the result of the depression of the nineties. The number of subsistence and part-time farms tends to increase with depressions since families who are out of work avail themselves of the opportunity to produce their own food while accepting temporary or seasonal work which may be available. Depressions are probably more nearly expressed, however, in fluctuations in numbers of farms under 20 acres (see appendix Table B). It is also likely that the temporary spurt in number of farms in the group 20-49 acres resulted as small bobtail segments of the near-exhausted supply of public lands were converted into individual farms and later were absorbed by larger units.

Recent Patterns in Farm Size Adjustments

Numerous forces which have bearing on farm size have developed since 1920. Some of these forces have been opposite in effect and perhaps others have not had full opportunity to gain momentum. Nevertheless, some trends for the state as a whole are discernible.

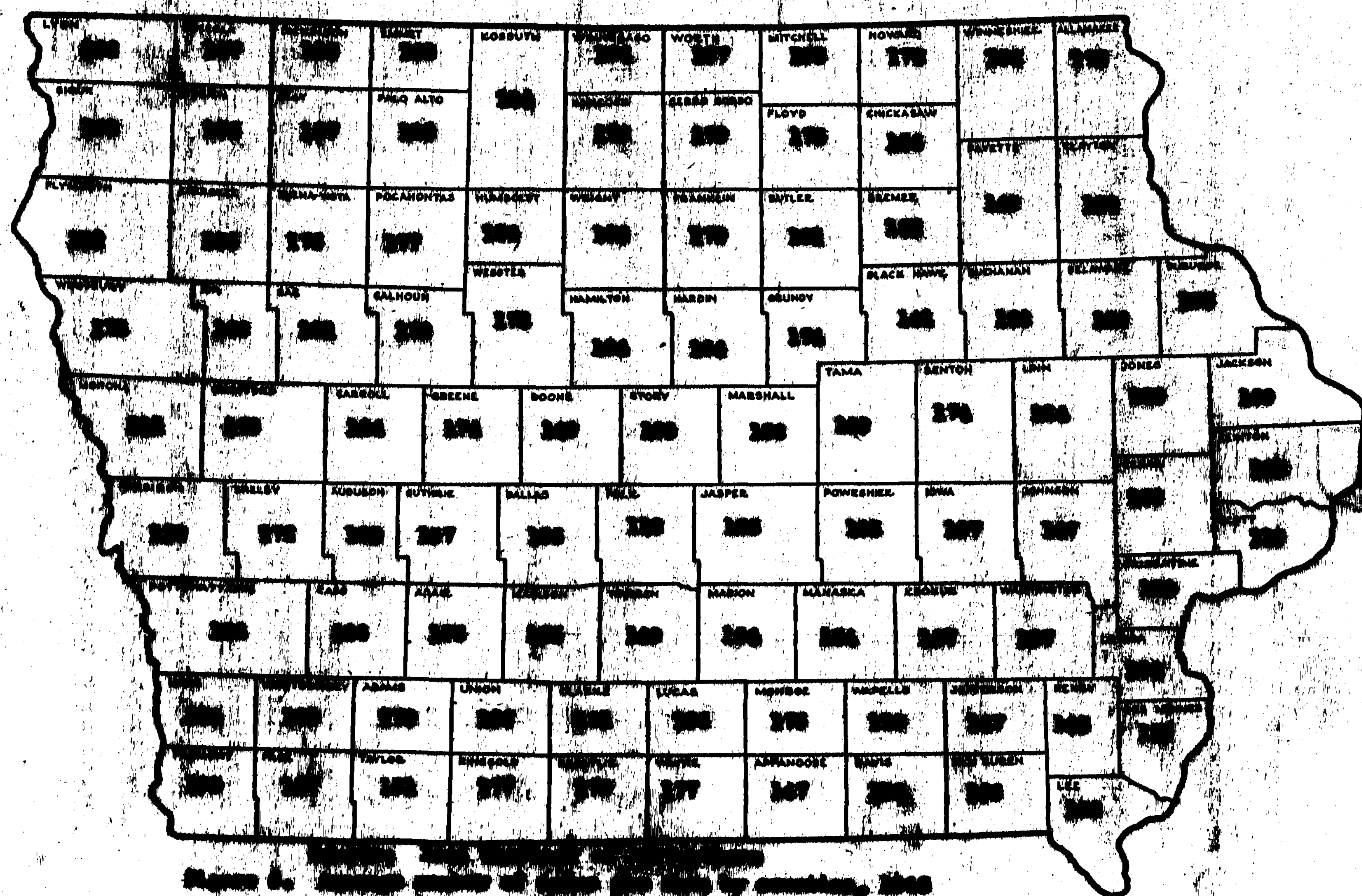
Forces arresting changes

There were two factors tending to temporarily arrest consolidation

and expansion of farms in the period 1920-40. These factors were drought and depression. The first depression, that of the early 1920's was relatively unimportant in checking expansion because of its short duration and because other stimuli to expansion were as yet unimportant.

The more severe depression along with the droughts of the early 1930's was undoubtedly a greater force in molding the pattern of adjustments and in acting as a resistance to expansion. A comparison of the 1935 census with that of 1930 and 1940 tends to bear this out. Although the five-year census is not strictly comparable with the decennial census, some reliability can be placed on the data for trends in farm size adjustments for farms of more than 20 acres in size and certainly for those of more than 50 acres in size.

There was very little change between the distribution of farms in these size groups for the period 1930-35. Farm operators generally considered themselves fortunate if they were able to maintain the existing unit. Of course drought or depression, or any other factors which force income to a low level, may in certain instances speed up farm consolidation. The consolidation of some farms can take place only if other operators leave the occupation either because they are forced to do so through competition within the industry or because they voluntarily turn to other alternatives. Many persons turned from farming to other alternatives in the Great Plains states during the 1930's simply because their incomes were low relative to other opportunities. This allowed a high degree of consolidation by remaining farmers. However, the combination of drought and depression did not open the way for as great a degree of consolidation in Iowa as a whole as held true elsewhere. Although many


LYON
EMMET
KOSSUTH
WORTH
MITCHELL
HOWARD
WINNESHIEK
ALLAMAKEE
CLAY
PALO ALTO
HANCOCK
CERRO GORDO
FLOYD
CHICKASAW
FAYETTE
CLAYTON
BUENA VISTA
POCAHONTAS
HUMBOLDT
WRIGHT
FRANKLIN
BUTLER
BREMER
WEBSTER
BLACK HAWK
BUCHANAN
DELAWARE
DUBUQUE
SAC
CALHOUN
HAMILTON
HARDIN
GRUNDY
TAMA
BENTON
LINN
JONES
JACKSON
CARROLL
GREENE
BOONE
STORY
MARSHALL
SHELBY
AUDUBON
GUTHRIE
DALLAS
JASPER
POWESHIEK
IOWA
JOHNSON
CASS
ADAIR
MARION
MAHASKA
KEOKUK
ADAMS
UNION
LUCAS
MONROE
WAPELLO
TAYLOR
RINGGOLD
APPANOOSE
DAVIS
VAN BUREN
LEE

farmers in Iowa did not have the capital to carry out any previously contemplated expansion, the largest proportion of them were able to maintain existing units. Expansion on the part of those who may have wished to rent additional land was less than it might have been due to the competition of tenants who were seeking a more favorable location after having passed through the prolonged drought in certain Great Plains states.

Of course some few individuals were financially able to take advantage of the low land prices and add to their holdings. Ownership of land by corporations reached a peak at this time yet most foreclosed farms were evidently maintained as individual units. Even if only farms of fifty acres and over are considered, no net consolidation seems to have taken place during the early thirties.

A material increase in the number of farms under twenty acres between 1930 and 1935 is indicated in appendix Table B. It is impossible to separate the proportion of this increase which might have arisen from the creation of new units from that which may have resulted from varying interpretations of a farm between different census years. However, it is possible that there was some increase in the number of small retirement and subsistence or part-time units during the early thirties. Town and city workers again turned to such units as a means of bolstering their low incomes or providing a livelihood in cases of unemployment. Also a large number of older farmers who might have otherwise moved to town or ceased farming altogether probably turned toward small semi-retirements which still brought in some income.

Long-run trends

Aside from the above mentioned temporary lulls in farm size adjustments the trend was definitely toward consolidation and larger units between 1920 and 1940. The average size of all farms over 19 acres in size increased from 165.3 acres in 1920 to 170.0 in 1930 and to 172.9 in 1940. Also as is indicated in Table 7, the number of farms in each of the size groups 20-49, 50-99 and 100-174 acres decreased from 1920 to 1930 and again from 1930 to 1940. The number in the group 175-259 increased between 1920 and 1930 but decreased in the 1930-40 period. On the other hand the number of farms falling in the groups 260-499 and 500 and over increased in each of the ten-year periods 1920-30 and 1930-40. The greatest percentage change for any one group was in the size range of 500 acres and over. The number of farms in this group increased by 28.2 per cent for the entire twenty years and by 20.9 per cent between 1930 and 1940. The decrease in the number of all farms over 19 acres was 5,222 for the twenty year period and 2,710 for the 1930-40 period.

It is evident that the rate of consolidation of farms was greater in the period 1930-40 than in the period 1920-30. This increase in the rate of consolidation took place in spite of the fact that for the state as a whole the tendency to adjust size was at least partially arrested during the depression and droughts of the early thirties. This means then that the rate of consolidation in the late thirties must have been considerably greater than that for the 1930-40 period taken as a whole. An examination of the 1935 census data tends to substantiate this belief.

The number of farms of 20 acres and over as indicated by the 1940 census was 3.2 per cent less than that shown by the 1935 census (See appendix Table B). The corresponding figure for the number of farms of 50 acres and over was 2.5 per cent for the five-year period. Although the enumeration of 1935 may not be strictly comparable with that of 1940 it is felt that these figures are fairly reliable since the greatest error in the five-year census (or even in the decennial census) is for very small farms.

Nature of consolidations

These consolidations have not come about through the joining of two small farms. If this had been true Table 7 would show a decrease in the number of farms under 100 acres, an increase in the number of the size groups 100-174 and 175-260 acres and a constant number in the larger size groups. Instead, the decrease in the number of farms in all groups under 260 acres and an increase in number for all groups over 260 acres indicates that the small farm has been consolidated with an already medium-sized or large farm. Too, medium-sized units have been absorbed by other medium-sized units since the decline in the number of farms under 100 acres was only 238 between 1930 and 1940 while the decline in the 100-259 range was 3,492. This also could have resulted as large farms expanded by adding either a medium-sized or small farm.

Actually it appears that consolidation of farms never reached the proportions commonly supposed in Iowa. One unofficial estimate implied that the number of families forced off of farms through consolidations was 5000 in the spring of 1940 alone (18). However, the number of con-

solidations was obviously much less than this figure. The consolidation of farms totaled only about 2.5 per cent for the entire five year period, 1935-40, or an average of .5 per cent per year if only farms over forty-nine acres in size are considered. The rate of consolidations was 3.2 per cent for the 1935-40 period or .6 per cent per year if all farms over nineteen acres in size are included. The absolute decrease in the five years, 1935-40, was 1,134 per year if only farms of fifty acres and over are considered and 1,296 if all farms of twenty acres and over are considered. For the 1920-30 period consolidations of farms of 20 acres and over averaged .12 per cent per year and for the 1930-40 period the average was .14 per cent per year.

Pattern of Change by Type-of-farming Areas

An examination of farm size changes for the state as a whole obscures part of the adjustments which have been taking place. An increase in one area tends to be cancelled out by a decrease in another area. An examination of size adjustments by type-of-farming areas partially eliminates this difficulty. The type-of-farming areas are not homogeneous enough to eliminate all such opposing trends but such a breakdown of the state is of some aid in this respect.

Northeast dairy area

Less change in farm size has taken place in the Northeast Dairy area over the past two decades than in any other area of the state.

Even then, the small change which has taken place tended to maintain or slightly increase the number of medium-sized farms. As a matter of fact there was no net consolidation of farms between 1930 and 1940. The total number of farms over nineteen acres in size in the area for 1940

Table 9. Number and percentage distribution of farms by size groups, Northeast Dairy area 1920, 1930 and 1940

Size group in acres	Number			Per cent distribution		
	1920	1930	1940	1920	1930	1940
20- 49	2354	2183	2181	6.0	5.6	5.6
50- 99	6700	6157	6416	17.0	15.8	16.4
100-174	17146	17186	17149	43.7	44.1	43.8
175-259	8556	8661	8674	21.7	22.2	22.2
260-499	4295	4506	4401	10.9	11.6	11.2
500 & over	290	285	333	.7	.7	.8
All farms over 19 acres	39341	38928	39154	100.0	100.0	100.0
All farms over 49 acres	36987	36745	36983	--	--	--

was 39,154 as compared to 38,928 and 39,341 for 1930 and 1920 respectively. A better comparison is made by considering only numbers of farms over forty-nine acres since this mainly excludes subsistence, part-time or retirement farms. As Table 9 indicates there have been practically no consolidations even in these groups. The number of medium-sized farms (100-174 and 175-259 acres) has been especially well maintained. The tendency has not been toward greater inequality in size of operating units.

Cash Grain area

Although some have taken place, the number of consolidations in the Cash Grain area has been relatively few as compared to the Southern Pasture and Western Livestock areas of the state. This is in contrast to what might be expected if mechanization alone were the causal factor. Mechanisation should have the greatest effect on farm size in an area where the land is relatively level and where cash grain is important to livestock as a source of income.

Table 10. Number and percentage distribution of farms by size groups Cash Grain area, 1920, 1930 and 1940

Size group in acres	Number			Per cent		
	1920	1930	1940	1930	1930	1940
20- 49	1748	1806	1864	4.6	4.7	4.9
50- 99	5478	4990	5203	14.3	12.9	13.6
100-174	17250	17249	16770	45.1	44.6	43.8
175-259	8039	8327	8046	21.0	21.5	21.0
260-499	5390	5903	5919	14.1	15.3	15.5
500 & over	370	392	467	1.0	1.0	1.2
All farms over 19 acres	38275	38667	38259	100.0	100.0	100.0
All farms over 49 acres	36525	36861	36395	—	—	—

There was some tendency toward an increase in the number of farms in the 20-49 acre group over the entire 20-year period, 1920-40 (Table 10). Also, the number of farms in the size group 50-99 acres, although decreasing

from 1920 to 1930, increased from 1930 to 1940. The increase in numbers for the small group probably represents an increase in the number of semi-retirement units and specialty units. The decrease in the total number of farms of twenty acres and over was 408 for the period 1930-40 while the decrease in the number of farms fifty acres and over was 466.

The trend which did take place was mostly in the direction of larger units. The only decreases in numbers took place in the 100-174 and the 175-259 acre groups. The 260-499 acre group made a slight increase while the 500 and over acre group made a relatively large increase. The fact that, although the number of farms in the smaller size groups increased, there was a net decrease in the number of all farms points to a net consolidation and expansion in acreage for all farms.

Western Livestock area

The Western Livestock area displays a trend which might have been expected in the Cash Grain area (Table 11). Although the changes were in favor of medium-sized and moderately large farms from 1920 to 1930, the shift was definitely toward larger farms in the 1930-40 period. Consolidations are evidenced in that the number of farms over forty-nine acres in 1940 was 1088 fewer than in 1930 and 741 less than in 1920. The corresponding figures for all farms of over nineteen acres are 1,116 and 923. Shifts out of the 50-99 and 100-174 groups and up into the next larger group are evidenced in Table 11. The number of farms in the

Table 11. Number and percentage distribution of farms by size groups
Western Livestock area. 1920, 1930 and 1940

Size group	Number			Per cent		
	1920	1930	1940	1920	1930	1940
20- 49	2155	2111	1962	4.9	4.7	4.5
50- 99	6815	6225	5983	15.4	14.0	13.8
100-174	19118	19476	18657	43.1	43.6	43.1
175-259	9646	9893	9460	21.8	22.2	21.8
260-499	6071	6400	6636	13.7	14.4	15.3
500 & over	486	489	670	1.1	1.1	1.5
All farms over 19 acres	44291	44594	43368	100.0	100.0	100.0
All farms over 49 acres	42136	42483	41395	---	---	---

500 and over group increased from 489 in 1930 to 670 in 1940 or by 37 per cent.

Southern Pasture area

Farm size adjustments in the Southern Pasture area parallel those of the Western Livestock area. The number of farms over forty-nine acres in size decreased by 870 for the period 1930-40 and by 1,783 in the entire 1920-40 period. The decrease for all farms over nineteen acres in size was 1,115 for the period 1930-40 and 2,497 for the 1920-40 period. As Table 12 indicates, the noticeable trend was away from the small and medium unit and toward the moderately large unit. This area is again

Table 12. Number and percentage distribution of farms by size groups
Southern Pasture area, 1920, 1930 and 1940

Size group	Number			Per cent		
	1920	1930	1940	1920	1930	1940
20- 49	3365	2995	2952	8.9	8.2	8.3
50- 99	8380	7237	7017	22.1	19.8	19.8
100-174	14697	13874	13126	38.6	37.8	37.0
175-259	6962	7173	6911	18.3	19.6	19.5
260-499	4088	4525	4774	10.7	12.4	13.4
500 & over	531	807	716	1.4	2.2	2.0
All farms over 19 acres	37993	36611	35496	100.0	100.0	100.0
All farms over 49 acres	34632	33416	32546	—	—	—

one in which a minimum of farm size increase might be expected as a result of mechanization. A smaller cultivatable acreage per farm, rough lands and small and irregularly shaped fields should make mechanization a force of less import. Yet the adjustments in farm size were again greater than for more level areas of the state.

Eastern Livestock area

Adjustments in farm size have also taken place in the Eastern Livestock area. Again the trend was in the direction of consolidation and larger farms. The number of farms in 1940 was less than that of either 1920 or 1930. The total number of farms of fifty acres and over in size decreased

Table 13. Number and percentage distribution of farms by size groups
Eastern Livestock area, 1920, 1930 and 1940

Size group	Number			Per cent[a]		
	1920	1930	1940	1920	1930	1940
20- 49	3495	3083	3044	8.3	7.6	7.5
50- 99	8588	7600	7526	20.4	18.6	18.6
100-174	17338	16987	16691	41.4	41.6	41.3
175-259	8211	8561	8361	19.5	21.0	20.7
260-499	4061	4212	4389	9.6	10.3	10.9
500 & over	332	363	407	.8	.9	1.0
Total farms over 19 acres	42015	40806	40418	100.0	100.0	100.0
Total farms over 49 acres	38520	37723	37374	—	—	—

[a]Per cent of total farms over 19 acres in size.

by 1,597 from 1920 to 1940 and by 388 from 1930 to 1940. The corresponding figures are 1,146 and 797 if all farms of twenty acres and over are included. The shift was out of the size range 20-174 acres and into the larger groups as is noted in Table 13.

Reasons for Recent Patterns of Change

What explains the recent patterns of farm size change indicated on the preceding pages? Obviously there have been some shifts toward larger units even though the shifts have not been as great for the state as a whole as some have suggested.

Effect of mechanization

An over-all force tending to bring about or make possible expansion during the periods under consideration was mechanization. The number of tractors on farms in Iowa increased from twenty thousand to thirty-seven thousand from 1925 to 1930 and to 124 thousand in 1940 (38). Similar increases in the number of other labor-saving machines have come about. This mechanization encourages larger units for three important reasons: (1) It makes possible the cultivation of a greater acreage with a given supply of family labor, (2) It results in fairly high fixed costs for the small unit with lower costs for the large unit, and (3) The tractor along with the truck eases the problem of traveling to distant units which may be operated in conjunction with the original unit.

Even though mechanization encourages operations on a greater scale for the reasons cited, it does not always force small-scale operators from their farm. It will diminish the income of the small-scale operator only if it results in an increased acreage and/or production of the crop and thus brings about a lower price for the commodities affected. Or it may force the small-scale operator from his farm only if it gives the large-scale operator a cost advantage so that he can pay higher rent or a greater price for the land. These points have been discussed in considerable detail in an earlier section of this study. However, it does not seem likely that mechanization alone has forced consolidation in either of the two respects mentioned above as far as Iowa is concerned.

Mechanization has resulted in some farm size expansion simply because it allows the labor of one family to accomplish more. For this reason consolidation has taken place not because mechanization results in a lower income for the small operator and thus forces him from the farm; it results indirectly as a nearby neighbor, who has the tractor and equipment necessary for the operation of additional land, is in a favorable bargaining position to acquire the unit in question. The fact that a majority of the rented farms in Iowa are operated under a crop-share lease tends to nullify the advantage which the large-scale operator might have in respect to costs and hence in his ability to pay rents.

Even then, not all families look upon the tractor and the accompanying high-capacity machines as a means of increasing the acres operated by the family. Often the labor-saving equipment has been used to offset a family member who has left the farm or to displace the hired labor which would otherwise be required.

The consolidation of farms has not kept pace with the degree of mechanization in Iowa. Mechanization as a factor causing expansion in the size of farms has been over-emphasized. Mechanization in Iowa should more properly be looked upon as making possible larger-scale operations when the opportunity for such has been opened by other forces.

The comparisons of farm size adjustments between type-of-farming areas within the state further emphasize the fact that mechanization as a force in farm size adjustment has been over-emphasized. Increases in farm size have been less in the level central area than in the rougher western and

southern parts of the state, areas in which cash grain is less important relative to other sources of income. Further, the Northeast Dairy area, which is comparable to the Southern Pasture area in topography, does not show like trends. The explanations are not to be found in topography and mechanization as such. The use of labor-saving equipment makes possible the cultivation of more acres per farm but the additional land must be available first. Additional land will be available for expansion on the part of some operators only if and as units are given up by others. Farming will be given up by operators either because (1) they voluntarily forsake the industry for more promising alternatives elsewhere, (2) they are forced to do so because others can outbid them in terms of land rents and prices or (3) others have a special "pull" in renting the land. The first of these, voluntary abandonment, may come about either because returns in agriculture are low or because incomes elsewhere are high. If income from farming is low, remaining operators may expand as additional land is available not merely for the greater income forthcoming from lower unit costs but because of the greater returns from a larger volume of business.

Low income forces

One factor alone has probably been more important than mechanization in molding farm size adjustments. This factor is the level of farm income as affected by any force whatsoever. The Southern Pasture area has long been the low-income area of the state. Likewise the rougher sections of

the Western Livestock area have had low incomes as compared to other areas. Parts of both of these areas were especially hard-hit by the droughts of the 1930's. Furthermore, the great depression added burden to the existing income problems in these areas. An examination of farm size changes county by county within the two areas further substantiates the belief that the level of farm income is crucial in bringing about adjustments. The counties with the greatest proportion of rough land or those affected most severely by the droughts showed the greatest upward shift in farm size.

Table 14. Changes in number of farms over 49 acres, 1930-40, by type-of-farming areas

Area	Change in number of farms over 49 acres in size 1930-40		Area decrease as per cent of state decrease
	Number	Per cent	
Northeast Dairy	+238	+ .5	a
Cash Grain	-456	-1.3	18.4
Western Livestock	-1088	-2.6	42.9
Southern Pasture	-870	-2.5	34.3
Eastern Livestock	-349	- .9	13.8

[a] Net increase in Northeast Dairy area. The total for the other four areas exceeds 100.0 per cent since part of the consolidations were cancelled by the increase in the dairy area when the state average is considered.

In contrast, farm income in the Northeast Dairy area has been somewhat more stable than that of other areas. The price of dairy products remained more favorable than other farm prices during the 1930's. The droughts were not so severe. This greater stability in farm income is probably expressed in a greater stability of farm size. The fact that

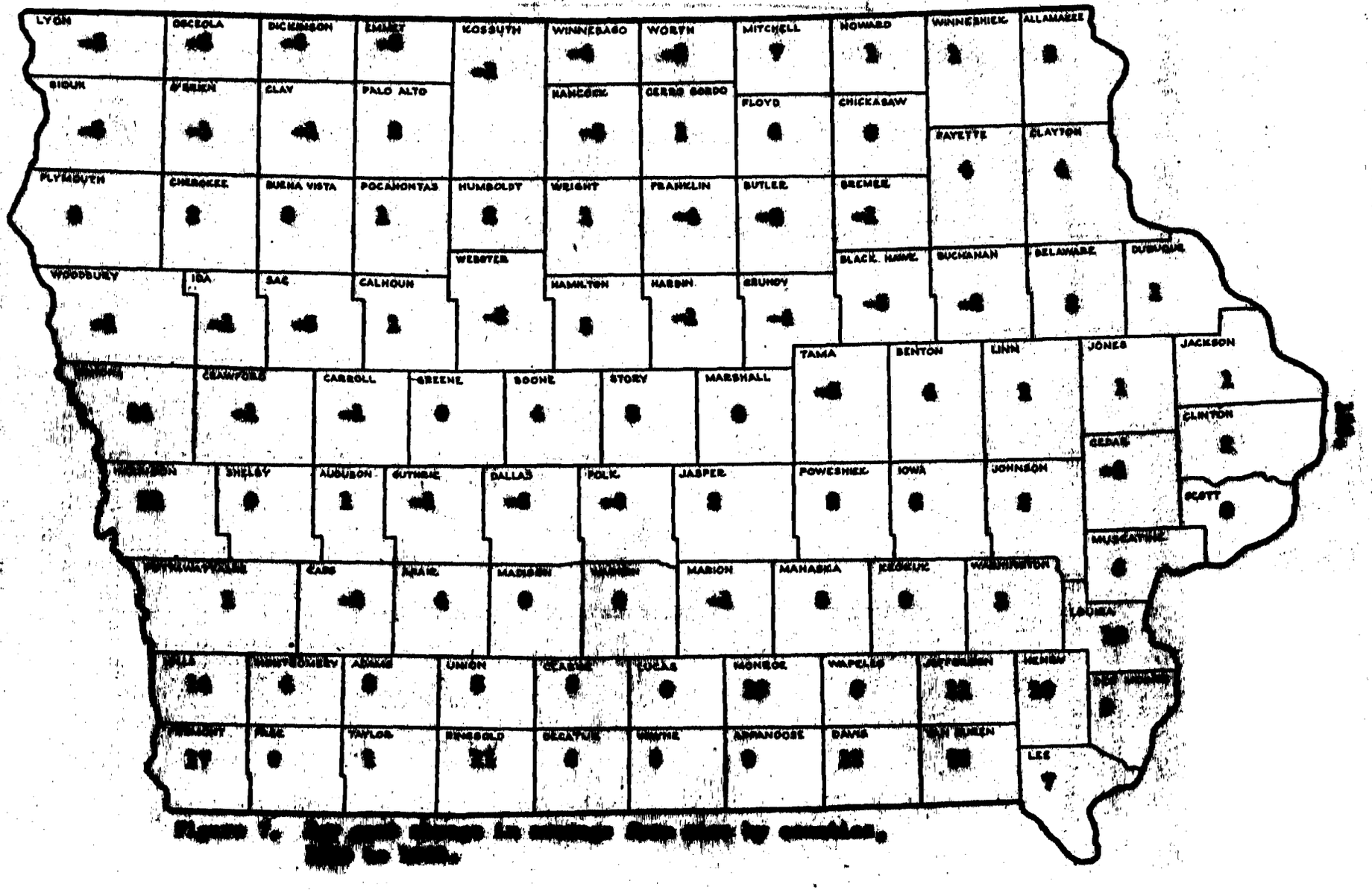


Figure 1. [illegible] in acreage [illegible] by counties, [illegible].

fewer individuals' incomes fall to the distress level means that fewer persons forsake farming to move into other alternatives. This in turn means that fewer farms can consolidate and expand.

Farm tenure and size adjustments

Another factor important in molding farm size adjustments is farm tenure. This force has evidently tended to partially offset mechanization in the Cash Grain area relative to farm size adjustments. On the other hand it has augmented low income as a force in bringing about adjustments in the Southern Pasture and Western Livestock areas.

Aside from a temporary reversal during the depression, the trend in number of full-owned farms in some counties of the Cash Grain area has been upward. Conversely, the number of full-owned farms has been on the decline especially in some of the hilly counties of western and southern Iowa. An examination of Table 15 suggests some relationship between changes in farm ownership and changes in farm size. In general an increase in the number of full-owned farms was accompanied by a decrease in the average farm size between 1920 and 1940. Increases in farm size accompanied decreases in the number of owner-operated farms.

This relationship centers around two things: (1) capital available and (2) the stability of tenure. The operator of a newly acquired owned farm is certain of long-term tenure. His organization of the farm is long-run in nature. He is able to intensify operations and fully utilize feeds and labor by expanding in the direction of livestock enter-

Table 15. Relationship of changes in number of owned farms and average farm size by counties, Iowa, 1920 to 1940

Counties grouped according to per cent change in farm size	Average per cent change in number of owned farms	Average per cent change in farm size
Increase of 5 per cent or more	-18	10
Increase of 1-4 per cent	-11	2
Decrease of 0-3 per cent	2	-1
Decrease of 4 per cent or more	7	-5

Coefficient of correlation between per cent change in farm size and per cent change in number owned farms of 0.6657 significant at 1 per cent level of probability.

prises. This is possible since his security of tenure now makes profitable the erection of buildings and equipment for livestock. If labor is his limiting factor then this intensive expansion (livestock) may necessitate an extensive contraction (acres) as he assumes ownership of a farm. If capital is his limiting factor then the down payment on the farm plus the greater investment in livestock and equipment may necessitate the operation of fewer acres. Too, once he is certain of his stay on the farm expansion in livestock may occasion less uncertainty than investing additional capital in land. The turnover of capital invested in land is slower than that invested in livestock and returns are subject to the tide of price fluctuations over longer periods.

The owner-turned-tenant may well react in the opposite direction especially if he is operating under a short-term lease and with no certainty as to future tenancy. He can not be certain when he will be

forced to move and it is likely that he will receive no compensation for permanent or unexhausted improvements if he does have to move. Accordingly, his livestock enterprise will be held in check relative to that of the owner. For this reason, and if both his available labor and capital allow, he is likely to operate more acres than he did as an owner. Too, he may take this means of supplanting his income since it does not necessitate a permanent and non-reclaimable investment should he be forced to move.

One additional group of farmers may turn to an even greater farm acreage than the full tenant. This is the part-owner group of operators. Included at one extreme of this group is the new owner who is not entirely limited by either capital or labor. His security of tenure may allow intensive livestock operations but at the same time the availability of resources allows him to operate a larger unit composed of both owned and rented lands. At the other extreme of this group is the new owner who has enough capital to buy a small acreage and the normal equipment but not enough capital to own and fully stock an adequate unit. Thus in order to maintain or augment income he will operate not only the owned unit but also an additional rented tract. This tendency is facilitated by the tractor and labor-saving equipment which allows a given amount of labor to accomplish more and by the truck which makes possible the operation of more distant tracts.

That size of farm is influenced by shifts between ownership and tenancy is also suggested by Table 16. Part-owner farms are larger than

tenant farms, which in turn are larger than full-owned farms.

Table 16. Average size of farm by tenure groups, Iowa, for specified years

Year	All owners	Farm tenure: Full owners	Part owners	All tenants	Managers
1920	148.1	139.9	183.5	166.8	228.8
1930	147.7	139.5	203.8	168.3	240.2
1940	151.5	151.6	229.0	168.0	298.5

Table 16 has further significance. It indicates that it has not been the full-owned farm which has increased in size as has sometimes been implied. Neither has the size of the tenant farm increased appreciably. It is the unit operated by the part-owner or the manager which has shown a very definite trend in the direction of larger size. Table 16 suggests that the typical consolidation has not been that of two rented farms. Instead it has been the consolidation of a rented and an owned farm which thus results in a larger part-owned farm.

Change or lack of change in size of tenant-operated farms is largely molded by the size of farms available. As long as the typical farm to be rented is 160 acres the modal size of the tenant farm will be so determined. If all absentee-owned farms over 80 acres were sold to owner-operators the size of the tenant unit would decrease accordingly. Were all under 240 acres acquired by owner-operators the change would be in the opposite direction. The tenant may occasionally rent an additional unit but he does not enjoy the same advantage here as does the owner.[1]

[1]The owner who is able to rent additional land then becomes a part-owner.

Often he will not have been in the community as long and thus may not have first knowledge of or first opportunity for a farm in which occupancy of buildings is not a requisite. Even though he be a competent farmer, the very fact that his stay in the neighborhood is less certain than for an owner of comparable efficiency puts him at a disadvantage. Further, landlords customarily prefer that any buildings be occupied. This condition is best met by the owner who has a volume of business great enough to merit the hiring of a married man. Once the tenant farmer has acquired enough capital to hire a year-round man who might occupy a second set of buildings he often purchases and moves to a smaller unit of his own.

Prospective Adjustments in Farm Size

An examination of assessors' reports (38) would suggest that farm consolidations and increases in size since 1940 have fairly well paralleled the 1930-40 pattern. The greatest increases in average farm size have come especially in the Southern Pasture area. This might be expected as many inadequate and low income units were left in favor of more attractive incomes elsewhere. The abandonment in turn gave some operators in the Southern Pasture area, where labor is not as fully utilized as elsewhere, a chance to expand their operations. Of course farm size adjustments have been hampered by wartime shortages. The tight labor situation and the limited amount of new machinery have tended to check expansion. This is especially true in those areas where labor was already being fully utilized.

The high level of income resulting from wartime prices may accelerate the tendency toward acreage expansion in the immediate post-war period when critical resources are again freely available on the market. Indications are that many farms will be financially able to purchase additional machines such as tractors, combines and cornpickers.[1] Thus the possibilities of operating a larger unit even with a given labor supply will exist.

The very gradual increase in the number of farms above average size will probably continue. This tendency may also be especially strong if the economy remains in a state of prosperity. A high level of farm prices, a greater supply of labor and a minimum of uncertainty would serve as additional stimuli in farm size expansion. Further, a high level of industrial wages relative to agricultural prices might uproot additional operators who have remained on inadequate units.

Temporary forces

At the same time this latter factor may be offset entirely or in part by the willingness of a large number of returning servicemen and older farmers to operate small farms. A considerable number of older farmers who have stayed on during the war have indicated the desire to retire to small or part-time units. Many returning servicemen may have to operate

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[1] For data substantiating this belief see Heady, Earl O., "Farm Machinery Prospects" Iowa Farm Economist, May, 1944.

small units at the outset because of limited capital and because it may be some time before they are able to spot more desirable units or are able to increase their competitive position.

Gradual adjustments

Aside from any temporary spurt in the number of small units, the gradual upward shift in farm size displayed in the past several years will be prevalent in the future for two simple reasons: The potential of larger units will be present because of the large number of tractors and other labor-saving machines on the market. On the other hand, consolidations can not take place until an additional unit is available in the neighborhood. If the consolidation is to take place through the addition of a rented farm to another rented farm or to an owned unit the operator contemplating the consolidation must be able to locate a farm within reasonable distance; he must wait until the present tenant moves on his own accord or until the landlord becomes dissatisfied with the present tenant and he must have greater pull or bargaining power than another tenant who may be able to move onto the farm and occupy the buildings. Similarly, the person who contemplates expansion through the purchase of additional land must find a unit within a reasonable distance, of a desirable size and at a reasonable price. If he has the capital and machinery available for an additional 40 or 80 acres it still may be impossible to carry out an expansion if only farms of 160 or 200 acres are being sold within a reasonable distance from his

original tract of land. This gradual increase in number of farms over average in size will also be safeguarded by the fact that the farm business is a one generation affair. As long as the single proprietorship remains the predominant form of ownership the typical beginning farmer will be limited in scale of operations to that which he can operate with a limited amount of capital.

Modal units

Some have predicted that in two or three decades the typical or modal size of farm will be 200 acres just as the 160 acre unit has been the modal unit in the past. It may be that the average size of farms in the state will be 200 acres in the future, although such will not be true even in three decades if the present rate of consolidation is continued. It is unlikely, however, that the modal size unit will be 200 acres. In order that the latter be possible it would be necessary, for example, that an equal number of 40 and 160 acre units be available. The number of single units of 40 acres each now existing is much less than the number of 160 acre units. Thus, in order to make possible expansion of most 160 acres to 200 acres some units which are now more than 40 acres would have to be divided into forties.[1] This is not the typical manner in which land is sold. Most farms are sold as a unit and such will continue to be true as long as the number of buyers is

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[1] A 200 acre unit can also be created by dividing, for example, a 320 acre unit into a 200 and a 120 acre unit. However, this adjustment is no more likely than the opposite mentioned above.

plentiful. For this reason the consolidation of the future will probably follow the pattern of the past. The unit of 160 acres will be combined with an 80, 40, 120 acre or other sized tract, depending upon which is available; the 240 acre unit will be combined with a 160, a 40 or even a 200 acre tract. Various combinations will likewise hold for other consolidations. Although an average farm size of 200 acres may come about in the next several decades, it is unlikely that a modal unit of this size will come about in a comparable period.

Although the trend outlined above seems most probable for the future, additional forces might also come into being. A move toward more ownership and less tenancy would encourage smaller units. This would be especially true were present tenants to become owners (in contrast to having owners add to their present holdings).

It is also possible that there may be some "unconsolidation" of farms in the future. During the depression years some older farmers retired, not by moving to town as is sometimes common, but by remaining on the farm and using only the building and lots. They did this simply because it was less costly than buying or renting a house in town. However, in order to retire on the farm it was necessary that the owner rent the farm land to a neighboring operator in case a tenant house was not included on the farm. This made possible the expansion of nearby farms. Should such remaining retired owners move to town after the war (which is now more nearly possible because of the high wartime farm income) the farm might again be operated as a single unit. Or as a greater number of

newly-retired farmers move to town after the war the possibility of expansion by others will be less than if the retirement were to come about through retention of the farmstead by the owner, as was the case during the depression.

Implication of Farm Size Adjustments

The adjustments in farm size which have been taking place in Iowa recently do not imperil the family-sized unit. The rate of consolidation has been much less than many have supposed. The very gradual adjustment which has been taking place has not revolutionized the size of the farm unit in Iowa and will not do so in the near future. Of course, a rate of consolidation equal to that of the late thirties (.5 per cent per year for all farms over 49 acres or .6 per cent for all over 19 acres) would mean a considerable increase in the farm size over a long period of time.

Contrary to such views as that of Johnson (41) the stability in size of the full-owned and tenant farms indicates that the beginning farmer still has an opportunity to get started. Competition has not forced him to take over a larger unit at the outset whether he be a tenant or owner. This will continue to be so as long as capital accumulation passes through its present evolution, as long as the individual proprietorship is prevalent in agriculture and as long as outside forces such as depression, drought and declining demands do not force large numbers of operators from the land.[1] The level of land values and prices for working stock

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[1] Depression results in a flow of people back to agriculture and the creation of very small units. But aside from this a long period of adverse income forces many operators off other farms thus paving the way for expansion by others.

at any one time is more important than the number of acres per farm in limiting the size of the owned unit which can be started with a given amount of capital.

There can be no criticism of farm size adjustments which have taken place in those areas of extremely low income and in which adjustment has come about through consolidation of unproductive and undersized units. Part of the recent consolidation in Iowa has been of this sort. A larger part, however, has resulted from the consolidation of a small or medium-sized unit with one already medium or large in size.[1] The first type, consolidation of two small units, usually comes about from the press of low incomes. The second type more often results from (1) mechanization and the fact that the operator can accomplish more with a given amount of labor or (2) the fact that the operator has the necessary capital and bargaining power to acquire the additional unit.

Certainly the consolidation of units undersized in terms of income and labor use should be encouraged. Enlargement of farms means greater income because of lower costs, but more importantly because of the greater volume of business.

As has already been pointed out, consolidation of farms has its effect in fewer farm families, in the number of rural business establishments that can be maintained and in less support, both in terms of dollars and members, for such institutions as churches and schools. However, in case farm prices lag downward after the war, society must decide between two

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[1] This is denoted by the upward shift in farms by size groups as indicated in Table 10.

ends: (1) fewer farm families which can support themselves on larger units at lower price levels because of lower costs and greater volume of business or (2) more farms, oft-supported farm prices and a less productive use of the nation's resources.

Some expansion in farm size does not mean that society must relinquish the family-sized farm. Actually a large number of units are not of family size, not because they are too large, but because they are too small. They do not provide adequate income and they do not allow a full use of the family's labor. This study has not been concerned with defining a family-sized farm. However, a criterion consistent with the welfare of both agriculture and society in general should certainly consider the use of labor. A farm should be large enough to allow a reasonably full and effective use of the family's labor. It would be highly desirable if more of the consolidations taking place were of a nature favoring the small inadequate unit.

It is again to be emphasized that although some farm consolidations have taken place in Iowa, the number is not nearly as great as has been commonly suggested. The trend has been gradual and will mean a sizeable increase in the acreage per farm only over a long period if present rates of consolidation continue.

Finally, should society deem smaller farms more desirable than the scale which may result from present tendencies, this end can be partially accomplished by a greater degree of farm ownership. The size of the full-owned farm (in acres) has been stable. It averages less than for the

tenant or part-owned farm. Accordingly, a shift from tenancy in the direction of ownership should mean a smaller size for all farms and, at the same time, a greater number of farms.

RELATIONSHIP OF FARM SIZE TO FARM INCOME

The number of acres in a farm is only one measure of size. This measure was the only one suited to the analysis of the problem under consideration in the preceding section. However, it does not always serve best when other problems of farm size are being studied.

Measures of Farm Size

The study of the relationship of farm income and related factors to farm size which is presented in this section necessitates the consideration of measures other than acres. The number of acres in a farm measures size extensively. It measures scale of operations satisfactorily for areas in which there exists a great deal of homogeneity as to soil type, topography and cropping pattern and where but little livestock is produced. Scale of operations can be increased, however, by adding livestock or crops which intensify operations on a given land area. A farm which specialises in livestock production may well be considered larger than another of like crop and total acres but which does not produce livestock.

Other common measures of farm size include total capital and work units. Although there is no one "best" measure of farm size either of these has an advantage over the acre measurement in that they include livestock and also take into consideration intensity of crop operations. Work units are used as the common denominator of size in most parts of

this study.

A work unit is considered as the amount of work performed by an average man in a ten-hour day. Hence, a dairy cow which requires 140 hours of labor per year constitutes 14 work units. An acre of corn which requires 16 hours constitutes 1.6 work units. The total size for any one farm in terms of work units is computed by (1) multiplying the numbers of each class of livestock or acres of each crop by the corresponding work unit conversion factor and (2) summing these products. The conversion factors used in this study are shown in appendix Table E. These are state averages and were used for all farms. For this reason they do not give a perfect measure of size. However, this disadvantage is far less than that associated with the acre measurement and an attempt is made to correct this weakness at a later point in the study. Whenever the term "size" is used in this section it refers to scale as measured in work units. Some comparisons between size as measured in work units and size in terms of acres are made in a later part of this study. In cases where size is being expressed in acres such will be indicated.

Source of Data

The data which serve as the basis of this section were obtained in two random samples in Iowa. One of these surveys was taken in 1939 and includes 732 farms.[1] The other was taken in 1942 and includes 510 farms.[2]

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[1]For a further explanation of the sample and the sampling method employed see Jessen, Raymond J. Statistical Investigation of a Sample Survey for Obtaining Farm Facts, Iowa Agr. Exp. Sta. Bul. 304. (1942)

[2]This sample originally included approximately 800 farms. These farms

The 1939 sample is satisfactorily representative. The 1942 sample, while less representative than that of 1939, is reasonably so.

It is fortunate that random data for these two years are available. Farm income comparisons under two levels of prices are thus possible. The 1939 data represent a situation under a near-average price level. The Iowa farm price index stood at 98 per cent of the 1910-14 level during this year. The year 1942 was one of moderately high prices. The level of all Iowa farm commodity prices averaged 170 per cent of the 1910-14 base in this year.

One particular difference between the 1939 and the 1942 surveys should be noted. The 1939 survey was taken at the close of the year and covered business transactions for the entire preceding twelve-month period. The 1942 survey was taken quarterly and each survey covered only a three-month period. For this reason the 1939 data probably include more memory bias (forgotten quantities) than do those of 1942 since the operator had to recollect business transactions and other figures for a twelve-month period in the former year as compared to a three-month period in the latter year.

Memory bias is not serious in the enumeration of such physical quantities as total acres in the farm, acres of each crop, number of cows milked, number of sows farrowed, amounts and kinds of labor used and other

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(footnote continued)

represented a random sample stratified by areas of the state. Schedules on farm business were taken quarterly. However, due to the fact that one or more schedules were not obtained for some farms a yearly summary of all 800 was not possible. These omissions were only very infrequently due to refusals and were more often due to the fact that the operator was not at home when the enumerator called. The average number of acres per farm for the 1942 survey was only 14 or 8.1 per cent greater than for the 1939 survey.

such large and infrequent happenings throughout the year. It tends to be greatest for quantities occurring frequently and in small amounts such as certain income and expenditure items. Because of the difference in method of enumeration the 1942 data may not be strictly comparable to that of 1939 in cases where memory bias is an important factor.

A greater memory bias in 1939 than in 1942 is not a serious obstacle in the larger part of this study since comparisons are not often made between the two years. In some sections the data of only one year have been used since it is apparent that similar relationships would hold for the other year. In other cases the data of both years are used, not as a comparison of the degree of relationship between variables in the two years, but merely to indicate the nature of the relationship between variables where it was felt that the data for two years served better than did the data for one year. Direct comparisons are made between the degree of relationship for the data of the two years mainly in one instance. The degree of relationship between farm size and farm income in 1939 is compared with that of 1942.

The data presented in this section are sample statistics. They are not population parameters such as was true in the preceding section. Hence inferences drawn as to population parameters are subject to the usual sampling errors.

Average Farm Size

The average number of work units per farm for all farms in the state was 345 in 1939 (Table 17). The average for the 1942 survey was 380, 10

Table 17. Average farm size in work units and acres by type-of-farming area, type of farm and tenure group, 1939 and 1942 surveys

Year, area, type of farm and tenure group	Size in work units		Size in acres	
	Average	Per cent of state average	Average	Per cent of state average
1939 Survey				
Area*				
Northeast Dairy	374	108	165	96
Cash Grain	377	109	180	105
Western Livestock	372	108	193	112
Southern Pasture	268	78	171	99
Eastern Livestock	329	96	154	90
Type of farm*				
Commercial cattle feeding	662	189	262	152
Crop	324	94	196	114
Dairy and hog	358	104	140	81
Dual purpose and hogs	436	126	211	123
General	333	97	175	102
Hog	333	97	166	97
State average**	345	100	172	100
1942 Survey				
Tenure group*				
Full owners	338	89	158	86
Part owners	591	156	280	151
Tenants	365	96	188	106
State average**	380	100	186	101

*Differences between work unit group means significant at the 1 per cent level of probability.

**Difference between work unit means for 1939 and 1942 significant at the 1 per cent level of probability.

per cent more than for 1939.[1] These figures should not be exactly comparable since the 1939 survey was more representative than that of 1948. However, the difference between the survey data of the two years is quite similar to the true difference for all farms as computed from the crop acreages and livestock numbers published by the United States Department of Agriculture (78) for the two years.

Type-of-farming area

In Table 17, the average number of work units per farm reveals a somewhat different pattern of farm size than does acreage alone. The average number of acres per farm in the Cash Grain area and the Western Livestock area is considerably greater than that of the other three areas. The average size in acres for the Southern Pasture area is only 1 per cent less than for the state average. However, a comparison of size in terms of work units shows no appreciable difference between the Northeast Dairy, Cash Grain and Western Livestock areas and only little difference for the Eastern Livestock area. On the other hand, the average size of farms for the Southern Pasture area, in terms of work units, was 22 per cent less

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[1] Some might wonder that the average farm would produce so few work units in 365 days since a work unit supposedly amounts to the labor of a ten-hour day. However, when Sundays, stormy days and slack winter periods are taken into consideration the number of work units shown is probably not far out of line. Too, the labor requirements upon which these figures are based probably do not include all the chore and repair work necessary. This last fact does not invalidate the comparisons as long as each type of enterprise bears the correct relationship to others. The work units used in this study are not exactly comparable to the productive-man work units used for some other states.

than the state average and 26 per cent less than the average of the other four areas. Most of the difference in size is removed between the four areas first mentioned since the work unit standard accounts for the greater intensity of operations in the Northeast Dairy and Eastern Livestock areas. This standard lends greater emphasis to the inadequacy of the size of many southern Iowa farms. A greater proportion of rough and non-tillable land and lack of feed necessitates less intensive operations. A given number of acres in the Southern Pasture area does not result in as great a scale of operations as in any other one area of the state.

Farm types

A comparison of work units per farm shows little difference between crop, dairy and hog, general, and hog farms.[1] Again the differences in

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[1] Farms were classified in the following manner:

General or diversified farms: Those with no single source of income - generally with three or more fairly important sources of income.

Crop farms: Crop sales equal to 30 per cent or more of the value of all crops raised and also equal to more than 25 per cent of total cash sales (includes the value of crops turned over to the landlord for rent).

Hog farms: One litter of pigs raised for each 8 acres (or less) of land in rotation.

Dairy and hog farms: One milk cow for each 15 (or fewer) acres of total land in farm and butterfat production over 125 pounds per cow.

Dual purpose cattle and hog farms: One breeding cow (in opening inventory) for each 18 (or fewer) acres of land and butterfat production less than 125 pounds per cow. Also with beef sales of importance comparable to butterfat sales.

Commercial cattle-feeding farms: Selling at least 30 cattle and buying at least two-thirds as many as sold.

size as expressed in acreage tend to be eliminated when livestock numbers are also included in scale of operation. The dual purpose and hog-type farm was 26 per cent greater in size than the average of all farms. Commercial cattle-feeding farms were 89 per cent greater. The dual purpose and hog-type farm, although using more labor than the average, was probably able to dovetail its enterprises in a manner which allowed more work units. Commercial cattle-feeding farms are large in every aspect; the number of acres per farm is greater than for the average farm and operations are carried out on a more intensive scale.[1]

Tenure groups

A comparison of work units by tenure groups for 1942 displays the same ranking as does a comparison of acres for farms so grouped: The part-owned farm is largest while the full-owned farm is even smaller than the rented farm. However, part of the gap between the full-owned and rented farm is closed when the work units are used as the measure of size.

This shift in relative rank is accounted for by the fact that the work unit standard (1) accounts for livestock as well as farm acres and (2) accounts for the fact that some crops are more intensive than others or that some types of livestock add more to volume of business than does a like number of other animals. Again, these comparisons emphasize an advantage in using work units instead of acres in measuring size.

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[1] In order that the terminology be kept as simple as possible in the remainder of the study "dairy and hog farms" will henceforth be indicated as "dairy farms", "dual purpose and hogs" as "dual purpose farms" and "commercial cattle-feeding" as "cattle feeding".

Correlation Between Income and Size

Net farm income was chosen as the measure of income in this analysis since it is more nearly a function of scale of operations than is net operator income. Net operator income varies on tenant farms with the type of lease and rental rates. Accordingly, in instances when both owners and renters are considered together the net operator income represents a composite of situations, the average of which fits neither group. Net farm income can be used satisfactorily to indicate the relationship of returns to size for comparisons by farming types, areas and other classifications. The tenant operator thus has some idea of the importance of size in each case. However, one comparison between net operator income on rented and tenant farms is made in this study since it is important that some idea of the relative returns of renting or owning farms of various sizes be had.

Net farm income as used in this study is the difference between total farm credits and total farm debits. Income from off-farm work and other outside sources is excluded. Interest payments have also been excluded as a cost since the surveys do not give an accurate accounting of all such payments. The tenant usually knows little about interest payments by the landlord even though he may be able to make a fair estimate as to taxes and other fixed expenses.

State averages

Table 18 shows the net returns for farms grouped according to size

in work units for 1939 and 1942. The 1942 income includes some increase in inventory values. Part of the increased inventory values resulted from increased production and part from the appreciation in value of capital on hand at the beginning of the year.[1] Accordingly, the full amount of income represented by the 1942 figure could not be considered as available for withdrawal from the business if scale of operations were to be maintained.

Table 18. Number, average size and net farm income of farms grouped according to work units, 1939 and 1942 surveys

Size interval in work units	1939			1942		
	Number of farms	Average number of work units per farm	Average net farm income per farm	Number of farms	Average number of work units per farm	Average net farm income per farm
0-149	82	96.0	356	53	98.3	1,356
150-299	258	229.9	865	174	232.4	2,863
300-499	224	366.7	1,712	173	376.0	5,144
450-599	97	511.0	2,518	63	514.5	7,505
600 & over	71	782.3	3,469	68	772.3	11,803

As Table 19 shows, 50.5 per cent of the variance in net farm income is associated with size for all farms in the 1939 sample. The corresponding figure for the 1942 sample is 52.5. The variance unaccounted for is explained in a multitude of other factors such as productivity of land, technical efficiency, amount of unpaid family labor, differences in manager-

[1] It does not include any appreciation in value of real estate since the value of the land was taken as the same in the opening and closing inventories. Buildings were depreciated except in the cases of improvement expenditures.

Table 19. Correlation of net farm income with size in work units by type-of-farming area, type of farm and tenure groups, 1939 and 1942 surveys

Year, area, type of farm and tenure group	Correlation coefficient r	Coefficient of determination	Fiducial limits of r at 5 per cent level of probability	
			Lower	Upper
All farms[x]				
1939*	.7106	.5050	.6726	.7448
1942*	.7245	.5249	.6789	.7634
Area (1939)[x]				
Northeast Dairy*	.7552	.5703	.6799	.8170
Cash Grain*	.6165	.3801	.5014	.7192
Western Livestock*	.7110	.5055	.6169	.7844
Southern Pasture*	.7363	.5421	.6508	.8043
Eastern Livestock*	.7688	.5911	.6965	.8257
Type of farm (1939)**				
Cattle-feeding*	.6464	.4178	.4166	.8096
Crop*	.7143	.5102	.5963	.8076
Dairy*	.8192	.6711	.7339	.8790
Dual-purpose*	.6224	.3874	.4770	.7399
General*	.6505	.4232	.5565	.7290
Hog*	.6430	.4134	.5359	.7516
Tenure (1942)[x]				
Full-owner*	.7495	.5618	.6844	.8049
Part-owner*	.6800	.4624	.5072	.7857
Tenant*	.7092	.5030	.6387	.7679

*Correlation coefficient significant at the 1 per cent level of probability.

**Differences between group correlations significant at the 1 per cent level of probability.

[x]Differences between group correlations non-significant at the 5 per cent level of probability.

ial ability, damage from disease and pests and others. It thus appears that no other one factor might be so closely associated with net farm income as is size.[1]

This statement is a generalization for all farms in the years studied. It does not mean that size is the most important factor on any one individual farm. Some farms, for example, might not increase income as much by expanding operations as by making other adjustments in their operations. An operator who is technically inefficient might increase income by the greatest amount if he were to curtail operations and improve efficiency. The operator who is technically efficient but is producing a product for which cost/price relationships are unfavorable would lose more only if he were to expand. He may actually increase income by contracting operations while shifting to more profitable enterprises. The correlation between income and size may even be negative in years of rapidly falling prices. These possibilities and others are not excluded by the statement that a major portion of the variance in farm income between farms was associated with farm size for the two samples studied.

As is indicated in Table 19, the correlation coefficient between net farm income and man work units was slightly greater in 1942 than in 1939. One might expect that in 1942, a year of high prices and lagging costs, farm size would be a more important factor affecting income. However, the differences between the correlation coefficients for the two years was not statistically significant. Scale of operations seems to have been as important in explaining variations in income in 1939 as in 1942. An additional unit of size added more to income in 1942 than in 1939 but

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[1]This statement refers to other factors which do not also include size.

a similar portion of the variance in income between farms was explained by farm size in the two years.

Type-of-farming areas

The correlation coefficients between size and net farm income for farms grouped by area are included in Table 19. Statistically there are no significant differences between these. Evidently size as an explanation of net farm income is as important in one part of the state as in others.

This last mentioned fact in itself is of economic significance. The smaller scale of operations in the Southern Pasture area relative to that of other areas was previously noted. The income of southern Iowa farms might best be put on a par with that of other areas by increasing the scale of operations. This would necessitate several major adjustments in the area. Size of operations might be enlarged through increased production of livestock and livestock products. This type of expansion would require the importation of much additional feed since the area normally has a feed deficit. Additional facilities for handling inshipments of grain and, in certain cases, the outshipments of livestock products might be required. Hence, expansion might in many cases best come about through an increased acreage per farm.

Income seemed to be most closely associated with size in the case of dairy and crop farms. This might be explained for crop farms since less skill is ordinarily required here than on a farm where livestock as well as crops is an important source of income. Losses from disease, pests

and other natural hazards generally vary less between farms in Iowa for crops than for livestock. Size explained a greater proportion of the variance in income for dairy farms than for any other type of farm studied. Although there is a great variation in the production and profit per dairy herd between all farms, this type of variation tends to be minimized within the dairy-type group of farms. The fact that the herds within this group of farms are more nearly on a comparable production level means that a greater proportion of the variation between farms can be explained by size and less by difference in technical efficiency.

Scale of operations explained a smaller proportion of the variance in net farm income on cattle feeding farms than for any other type. The reason for this centers partly on the fact that these farms typically operate on a large scale. Very few medium-sized or small farms were included in the sample of cattle-feeding farms. As is pointed out in a later part of this study, the scatter diagram of income plotted against size shows a greater dispersion for large farms than for medium or small farms for all types of farms. Hence, it is likely that had the group of cattle-feeding farms included more medium-sized or small farms, the correlation between size and income would have been greater.[1] Equally or more important is the fact that there is more variation in types of

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[1] This statement does not mean that if a group of cattle-feeding farms were selected so that a larger proportion of small farms were included the correlation coefficient would be more nearly representative of the population. The correlation coefficient might be increased by such a procedure but it would be less representative of the population than the coefficient for the random sample.

operation between cattle-feeding farms than for other types of livestock production. Returns may vary from one year to another depending on the type of cattle fed, type of feeding operations employed and buying and selling prices. Although some variation in methods does exist, such livestock production as pork or dairy products tends to approach greater uniformity between farms than does cattle-feeding. Further, cattle-feeding is an enterprise with a greater degree of speculative risk than are most other enterprises in Iowa.

A smaller correlation between income and size might be expected for general farms since they were defined as farms which followed no definite pattern of organization. Income might well vary between farms of the same size and of comparable technical efficiency depending on the major products sold and the prices received. Too, there is an apparent explanation for the relatively smaller association between income and size on hog and dual-purpose farms. Technical efficiency and the mischance of physical hazards and disease are especially important factors affecting returns from pork production. Likewise, the production per cow varies much between those milk cow herds which cannot be truly classed as dairy herds.

Returns to scale

The relationship between net farm income and size as measured in work units appeared to be one of constant returns to scale. This conclusion was first drawn by an inspection of income plotted against size for each individual farm. An examination of the data presented in

Table 20 further suggested that this general relationship holds for all farms taken together.

The figures of Table 20 test the hypothesis of constant returns to scale. They indicate the upper and lower limits of the average elasticities at the 1 per cent level of probability. The true elasticities indicate the nature of the production function involved. If returns to scale are constant the elasticity will be unity.[1] An elasticity greater than 1 indicates increasing returns while an elasticity of less than 1 indicates decreasing returns to scale.

The hypothesis that the average elasticity is unity (constant returns to scale) would be rejected at the 1 per cent level of probability only in the case of the Cash Grain area. In this case the upper limit is less than unity.[2] This suggests decreasing returns to scale in the area for all farms taken as a group.

It seems logical that this relationship might well hold true. The crop acreage in this area is greater than in others although it is not twice as great. A relatively large number of farmers may have added a second power unit or a second set of machinery. Thus decreasing returns to scale would be realized if certain machines were duplicated while

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[1] Tintner (74) gives a more detailed description of the analysis involved in testing the hypothesis of constant returns to scale. The test employed here is not identical with that which he outlines although it is of the same general nature.

[2] At the 5 per cent level of probability the lower limits for the Eastern Livestock and Western Livestock areas was greater than unity. This would suggest increasing returns to scale. However, the lower limits were very near to 1.

Table 20. Fiducial limits of average elasticities at the 1 per cent level of probability, 1939 and 1942 surveys

Year, area, type of farm and tenure group	Fiducial limits	
	Upper	Lower
1939 Survey		
Area		
Northeast Dairy	1.2721	.8729
Cash Grain	.9806	.5382
Western Livestock	1.7660	.9436
Southern Pasture	1.3972	.9138
Eastern Livestock	1.4153	.9997
Type of farm		
Cattle-feeding	2.1200	.6359
Crop	1.3768	.7621
Dairy	1.4800	.9891
Dual-purpose	1.5028	.7056
General	1.2296	.8984
Hog	1.4277	.7191
1942 Survey		
Tenure		
Owner	1.2954	.9462
Part-owner	1.8854	.9252
Tenant	1.1274	.7725

acreage was increased by less than twice the original amount due to the discontinuity in the supply of these factors.[1] However, since the upper limit was close to unity this case may only represent a sampling variation.

The procedure outlined above tests the hypothesis of constant returns to scale for the farms in each group. It might well be that although the function is most nearly linear for all farms taken together, the function could be different for small farms than for large farms. The inspection of the scatter diagram suggested constant returns to scale throughout each group. However, the distribution of variates about the line of regression was heteroscedastic. That is, the variation of individual farm incomes about the computed line of regression were not equal for the various intervals of size.

The scatter was quite uniform for the 0-750 range of work units per farm but varied widely for farms of greater size. The fact that the distribution of the variates was heteroscedastic in the manner mentioned is meaningful. The incomes of average or relatively small farms tend to vary within a fairly narrow limit. On the other hand there appears to be no modal income for larger farms. Incomes were either considerably above or below the regression line. Successful large farms are exceedingly so while the less successful do no better than for somewhat smaller units. There appears to be little or no in-between. The successful operators are cut out for the job and have the ability necessary for large

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[1] This suggests that had the correlation analysis of Table 19 been one of a curvilinear relationship for the Cash Grain area the proportion of the variance in net farm income explained by size would have been greater than that indicated.

undertakings. The unsuccessful are just not "large scale operators" and might, in some instances, have incomes as large or larger were they to operate smaller units on an efficient basis.

Relationships of Other Measures of Size to Income and Work Units

Work units are not a perfect measure of farm size since they do not directly take into consideration the produtivity of land or livestock. Two farms of like acres and livestock numbers will be shown as of the same size even if productivity of land and livestock is high on one farm and low on the other when work units are used to measure scale of operations. Actually the inputs of productive factors will be greater on the more productive farm since it will require more labor and other resources.

Addition of capital as a variable factor

This fact may be at least partially accounted for by the addition of capital as an independent variable. The greater value of the higher-producing land and livestock will account for the greater productivity and hence, roughly, for the differences in size not explained by work units alone. To get evidence on this point Table 21 has been computed. It indicates the increased variance in net farm income attributable to the inclusion of total capital in the analysis.

The correlations suggest that a significant proportion of the var-

iance in net farm income was in practically all cases accounted for by the inclusion of total capital. Although work units alone explained 50.6 per cent of the variance in income between all farms in 1939, work units and total capital together explained 54.5 per cent. The corresponding figures for the 1942 sample are 52.5 and 61.0 per cent. Although there is some doubt in the cases of crop and dairy farms, somewhat similar significant increases in the variance of net farm income have been accounted for in all other groups of farms studied with the exception of cattle-feeding farms.

The values of R^2 in Table 21 may be looked upon as somewhat indicative of the degree of association between farm size and net farm income when that portion of farm size related to inherent productivity of land and livestock has also been considered. (In contrast to the figures of Table 19 which do not fully measure farm size since they do not account for the fact that either inputs of resources or output of commodities may be greater for land or livestock of relatively greater inherent productivity). Not all of the increased variance in net farm income explained by the addition of total capital to the correlation analysis can be attributed to an accounting of size not expressed in the work unit standard. This can again be best illustrated by use of a hypothetical example: The inherent productivity of two separate tracts of land is such that the yield of corn on the first is 80 bushels and on the second 40 bushels. In terms of physical output, the scale of operations on the 80-bushel land is twice that of the 40-bushel land. In terms of physical inputs, the scale of operations on the 80-bushel land will be greater than that on the 40-bushel

Table 21. Correlation between net farm income and income estimated from work units (X_1) and total capital (X_2)[a] 1939 and 1942 surveys

Year, area, type of farm and tenure group	Correlation coefficient R	Coefficient of determination	Difference in proportion of variance in farm income accounted for by adding capital to correlation analysis	
			Difference[b]	Value of F
All farms				
1939	.7390	.5450	.0400	63.79**
1942	.7821	.6101	.0852	110.80**
Areas (1939)				
Northeast Dairy	.8137	.6576	.0873	37.47**
Cash Grain	.6327	.3917	.0116	4.98*
Western Livestock	.7449	.5549	.0494	15.31**
Southern Pasture	.7807	.5723	.0302	9.27**
Eastern Livestock	.7944	.6264	.0353	14.96**
Type of farm (1939)				
Cattle-feeding	.6531	.4265	.0087	.52[z]
Crop	.7467	.5299	.0197	3.51[x]
Dairy	.8292	.6801	.0090	2.56[x]
Dual purpose	.7529	.5561	.1687	31.17**
General	.6854	.4622	.0390	10.08**
Hog	.6896	.4696	.0562	18.75**
Tenure group (1942)				
Full owner	.7741	.5955	.0837	17.92**
Part-owner	.8023	.6307	.1683	25.06**
Tenant	.7649	.5815	.0785	4.33*

[a] All correlation coefficients significant at the 1 per cent level of probability.

[b] Difference between variance accounted for by simple correlation of Table 19 and multiple correlation of Table 21.

[z] Non-significant statistically.

[x] Significant at the 20 per cent level of probability.

*Significant at the 5 per cent level of probability.

**Significant at the 1 per cent level of probability.

land, although not twice as great. However, the value of the 80-bushel land may well be more than twice that of the 40-bushel land since costs per unit of output will not be twice as great. Thus the inclusion of total capital in the correlation analysis not only accounts for size not explained by work units but also relates to net farm income some other factors which are associated with size.

In most of the remaining parts of this section it has been necessary to use only one measure of farm size. The measure which has been used is work units. It is of course true that the number of work units per farm and the total capital employed are highly correlated. It might thus seem that one of these standards should serve as well as the other as a measure of farm size. This is not far from true, yet it appears that there are some advantages in using work units as the standard in cases where only one measure can be handled conveniently. The total capital investment does not always indicate the scale of physical operation accurately either in terms of input of productive resources or output of commodities. For example, one person might own 320 acres of land valued at $200 per acre on which little or no crop production has been carried on during the year while another person operates 160 acres valued at $150 per acre and on which intensive livestock or crop operations have been carried out. The use of capital as the measure of size would place the first of these two farms far above the second in regard to scale of operations while in terms of all inputs including land or in terms of output the second may actually be largest. There are other important reasons why work units may serve better than total capital. In two years of different price levels the

latter measure would indicate that the scale of operations was different on a farm even though the input of productive factors or the output of commodities were identical in the two years. This difficulty is not encountered when work units are used as the measure of size. Too, management is brought into consideration more by the work unit standard than by total capital.

Relationship of acres to income and work units

The addition of acres as a variable in the correlation analysis did not account for any significant portion of the remaining variance in net farm income not explained by the two factors previously analyzed. It is easy to see why this was true. The work unit standard accounts directly for all crop land since acres of each crop are converted into work units. It also accounts indirectly for all pasture land since the livestock numbers are converted into work units.

Although such is not a physical necessity the number of acres per farm is positively correlated with the number of work units per farm in Iowa.[1] A large number of work units per farm tends to be associated with a large number of acres per farm (Table 22). This relationship springs from

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[1]The first part of this statement is true within certain limits. The scale of operations can be increased by the production of more livestock or more intensive crops on a given sized farm as well as by taking on more acres. There is, however, a limit to the amount of livestock or capital which can be used per acre of land. This ultimate physical limitation has little meaning in Iowa since intensification has reached this point on few if any farms.

basic principles of farm organization. The farm which increases the number of acres is confronted with the problem of a balanced utilization of resources and the most profitable disposal of crops. An increase in acres brings

Table 22. Relationships of acres and work units per farm, 1939 and 1942 surveys

Size interval in work units	Average number of acres per farm	
	1939	1942
0-149	60	58
150-299	128	151
300-449	186	181
450-599	236	235
600 & over	350	360
Correlation coefficient	.7305*	.7669*

*Significant at the 1 per cent level of probability.

about peaked seasonal labor and power requirements unless accompanied by livestock to fill in the slack periods. The livestock often represents one method of utilizing roughages produced in the rotation or in selling other feeds at a greater return. On the other hand, an operator who initiates an intensive expansion (greater livestock numbers) may find more extensive expansion (additional acres) is desirable in order that feed be available. This is especially necessary in the case of roughage-consuming livestock.

Should not the close relationship between acres and work units mean that the two measures are equally reliable in estimating net farm income? This would be true were work units and acres perfectly correlated. However,

this condition does not hold. Acres per farm explained only 53 per cent of the variance in work units per farm in 1939 and 51 per cent in 1942. It is not the number of acres per farm alone but also the number and acres of each type of livestock and crop respectively which explains the aggregate size of the farm business.

The relationships outlined above should not be forgotten when farm size adjustments are being considered. Yet this is not always true. At one extreme is that group which especially worries about the acreage increase of some farms. They tend to forget that the remaining land area would support the original number of farms at the previous aggregate size were they smaller in acreage while greater in intensity of operations. For this reason, in attempting to find means of maintaining a maximum number of family farms, they often turn in the wrong direction. Representative of this is the suggestion that legislation limiting the number of acres per farm be enacted. As is indicated in other parts of this study the full-owned farm is smaller in acres but greater in intensity than the tenant farm. Thus, credit and tenure institutions which allow either more full-owned farms or greater security of tenure may in part be a more basic answer to the question at hand.

At the other extreme is the group suggesting that in a state such as Iowa operations on the present number of farms should be intensified to a much greater degree in order to increase the state's agriculture and make possible support of a greater number of people. This suggestion is more or less paralleled by the argument that an increase in number of farms should be brought about through a decrease in number of acres per farm,

this diminution to be offset by greater intensity of operations. The supporters of these views overlook the fact that some balance between intensive and extensive expansion (or contraction) is necessary. Further, there is a limit to which scale can be increased or maintained through a greater intensification of operations on all farms. The maximum amount of feed which can be produced would not allow a high degree of simultaneous intensification by all farms.

Farm Organization

A study of the relationship of farm size to farm income brings up the question of the operator's managerial ability. Is it that the most efficient operators are on the large units while the less efficient are small scale operators? Is it possible that the greater income of the large unit is a result of the operator's managerial and technical ability rather than size as such?

Were it possible to measure and rank the ability of farmers in a single index the answers to such questions would not be difficult to obtain. Techniques either simple or elaborate might be employed. However, no single objective measurements exists. The ability of the operator makes its appearance in several ways. It may be particularly manifested in the over-all selection and combination of enterprises; in technical efficiency and hence production costs; in organization of productive resources; in adjustments to price situations or in other manners. One of these factors, selection and combination of enterprises, has already been taken into consideration. This is true since the

correlation of income to farm size was analyzed by types of farms.

Organization of business

Additional comparisons which will give an indication of whether or not the relationship between income and farm size is confounded with the ability of the manager are possible from the data available. Table 23 shows the proportion of total work units made up of crops and livestock in both 1939 and 1942. There were no striking differences in the relative importance of livestock or crops between size groups in either of the two years.

Table 23. Distribution of total work units between crops and livestock, 1939 and 1942 surveys

Size interval in work units	Number				Per cent			
	Livestock		Crops		Livestock		Crops	
	1939	1942	1939	1942	1939	1942	1939	1942
0-149	61.8	64.5	34.2	33.9	64.4	65.6	33.6	34.4
150-299	145.1	147.0	84.8	87.9	63.1	63.2	36.9	36.8
300-449	226.6	236.7	140.1	139.8	61.8	62.9	38.2	37.1
450-599	323.0	305.5	188.0	209.0	63.2	57.6	36.8	42.4
600 & over	508.3	492.0	274.0	280.3	62.4	63.7	39.6	36.3

Crop and livestock returns

Two efficiency factors which indicate both managerial and technical ability are the gross value of crops per crop acre and the returns per $100 feed fed. These two are, in general, the most important over-all efficiency factors in the crop-livestock economy of Iowa's agriculture.

They are dependent not only on rates of production but also on whether or not crops and livestock have been combined in the most profitable manner (in light of existing price relationships). Table 24 indicates the gross value of crops per crop acre and the returns per $100 feed fed by size groups for 1939.

Table 24. Average gross value of crops per acre and returns per $100 feed fed, 1939 survey

Size interval in work units	Gross value of crops per crop acre (dollars)	Returns per $100 feed fed (dollars)
0-149	15	194
150-299	15	177
300-449	16	165
450-599	17	170
600 & over	18	151

No correlations were computed but scatter diagrams were made for each of these two factors. These suggested very little correlation between either farm size and returns per $100 feed fed or between farm size and gross returns per crop acre. However, to the extent that any relationships did exist they were as indicated in Table 24. Certainly there was no positive correlation between farm size and returns per $100 feed fed. It is very likely that the quality of the land was as influential on crop returns as any superior management associated with larger farms might have been. The value of land per acre tended to be greater for larger farms.

Managerial ability

In light of the fact that positive correlations between income and size existed even for farms grouped by type, the fact that returns from livestock production were at least as high on small as on large farms and the fact that the portion of total work units represented by livestock and crops were similar in all cases, suggests that operator ability as manifested in organization of the farm and in technical efficiency did not vary greatly between farm sizes. This would indicate that for a given grade of management the relationships between size and income as already indicated are valid. This should not be interpreted to mean that every operator included in the study might manage a large farm equally well were he given the opportunity. Probably some individual small-scale operators might realize even less net income were they to take on a large unit, or some of those on large farms might actually have greater incomes were they to operate a smaller unit. There are many operators on small farms who might operate a large farm with an equal degree of efficiency. On the other hand some operators who are handling their own small unit as efficiently as large units are being handled by others might not possess the characteristics necessary to operate a large unit with the same degree of efficiency. Further, some operators who have the capital for a large unit but who operate it efficiently have greater incomes than if they were to operate a small farm with an equal degree of inefficiency -- the benevolence of nature simply more than offsets their lack of technical and managerial

ability. These and other possibilities are not precluded by the statements already made. The fact that farm size may explain a major portion of the variation in farm income for all farms studied does not mean that this is the most important factor on any one farm. Or the statement that, as a group, farms falling in the various size ranges seem to be operated with comparable efficiency does not mean that all operators can manage large farms equally well.

Case studies

In order to investigate these possibilities further a few case studies have been made. Farms which deviated widely both above and below the regression line of net farm income on work units for 1942 were examined individually. A brief description of these follows.

1. Farm A represents a large unit with an income several times greater than might be expected on the basis of the regression of income on size for all farms. This farm of 1740 work units, operated by a young operator, had a net operator income of $59,170 and a net farm income of $61,514. The gross income was $111,904. The farm included 560 acres, 160 of which were owned and 400 of which were rented. Two hundred seventy-five of the 400 were cash rented. Of the 560 acres 526 were cropped and included 190 acres of corn, 136 acres of soybeans, 83 acres of oats and 137 acres of alfalfa and red clover hay. Yields for crops were above the average for the county; the corn averaged 94 bushels per acre, oats 57 and

soybeans 27. Livestock was the most important source of income. The gross income from livestock was $93,685. Thirteen thousand chickens were purchased and 12,190 were sold; 296 head of cattle were fed on the farm and 270 hogs were sold during the year. Livestock returns per $100 feed fed were $480. The farm employed the equivalent of 6 full-time men during the year. The operator's equity in working and liquid assets was $38,964 and in fixed assets was $11,400. This farm carried a high degree of risk and uncertainty in its exceedingly large volume, in the large amount of working capital and in land rented on a cash basis. It required a manager capable of handling other workers in a manner resulting in high productivity per worker. Probably only a few outstanding managers could operate a unit of this nature successfully.

2. Farm B represents a small unit with income twice that which might be expected. This owned farm, with only 147 work units, had a net operator income of $4,110. Livestock and crops were of near equal importance on this 80 acre farm. Crops grossed $37 per acre while the livestock returns were $209 for each $100 feed fed. The virtues of this operator were found in both the fact that rates of production were high and in that he kept expenses at a very low level. Little of the income represents appreciation of inventory values. The cost of machinery per crop acre was $1.41 while the cost of machinery and fuel was only $2.64 per acre. Livestock and crop enterprises dove-tailed well and no labor was hired. It

is entirely possible that this operator might operate a larger farm with an equal degree of success.

3. Farm C with 1,389 work units might have been expected to return a farm income of better than $18,000. The income was only $8,095. This farm of 877 acres included 577 owned and 300 rented for cash. Livestock was the most important source of income even though 300 acres were cropped. Crop yields were low even when compared with other farms of the area. The gross value of crops per acre was $18. Livestock included dairy cows, beef cows, feeder cattle, sheep and poultry. Returns per $100 feed fed was only $125. Only 3.5 pigs were saved per litter; dairy cows averaged 205 pounds of butterfat and hens averaged 104 eggs. The farm was highly mechanized and a relatively small amount of labor was used. Actually it appeared that the operator was attempting to spread a small amount of labor over too great an outlay. This farmer might well have had a greater income had he been operating a smaller unit on a more efficient basis.

4. Farm D, a moderately large farm with 835 work units, had a net income of only $1,800 while four times this might have been expected. This operator depended equally on livestock and crops as sources of income. Crop yields were about average. The dairy and poultry enterprises were operated with a high degree of efficiency but profits here were evidently offset by the hog and feeder cattle losses. Low returns on the hog enterprise were not due to high death losses but

more likely to inefficient feeding methods. An average number of pigs was saved per sow. Machinery and power expenses per crop acre were high. Again, this operator was one who might have best increased income by improving efficienty rather than by expanding scale of operations.

An examination of the above and other individual farms which deviated widely from the regression line indicated several things of importance. It appeared that there were many operators of small units who might have the ability to manage larger units. At the same time there were operators of large units who would probably have had greater income had they concentrated more effort on fewer work units. Some of the very large farms certainly could not be operated by the average operator.

In summary it can be said that the major portion of variation in farm income in 1939 and 1942 was associated with scale of operations. Organization and efficiency of operations for small farms as a group was comparable to that of larger farms. However the characteristics of the individual are important. Some farmers are more nearly suited to large scale units than are others. These points should not be overlooked by prospective farm operators or those agencies concerned with settling operators on the land. In the first place it is of prime importance that the scale be large enough to provide an adequate family income. A size range probably exists for each operator within which he can operate with equal efficiency. For some operators this range may extend only

up to 250 work units; others may be able to handle 600 units as well as less. Still others may handle 2500 work units as efficiently as 200, 600 or 1500. The individual should, of course, be encouraged to push to a size great enough for an adequate income but not beyond the size range which matches his managerial capacity.

Costs and Returns by Scale of Operations

Net farm income might conceivably increase with scale of operations in two different manners: (1) It might result from lower costs as productive factors are combined more economically and as fixed costs are spread over a greater output[1] and (2) It might result from greater volume alone even though costs were to remain constant or if output were pushed beyond the low cost combination and as long as the addition to cost was less than the addition to income.

Many persons have pointed to the first of these as all-important in agriculture. Predictions of large-scale and corporate farming generally rest on this factor. Some persons emphasizing this factor suggest that cooperative ownership of machinery and equipment represents a means of closing the cost and income gap between large and small farms.

Table 25 has been prepared in order to provide some answers as to the relative importance of costs on farm income as scale of operations

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[1] Actually the two are identical inasmuch as a different combination is necessary to lower fixed costs. However, a new combination of some factors which increases returns can be made which does not lower average fixed costs.

is increased. More elaborate measures might have been employed in expressing this relationship. Correlation analysis might have been used or cost curves might have been constructed. Instead, a simple but more vivid device has been employed. Table 25 indicates the share of the additional net farm income due to lower costs alone and that due to greater volume alone between size groups for 1939. The increased income due to size for each size group has been computed by multiplying the decrease in costs over the next smaller size group by the units of gross income. The increase due to volume alone is approximately that which would have been forthcoming if average costs had remained constant as size was increased from the average of one group to that of the next.[1]

Cost relationship

The group of largest farms, taken as a whole, had pushed scale of operations beyond the low cost combination. They had not, when considered as a group, reached a point of equal marginal cost and marginal revenue.[2] Costs per $100 gross decreased at a rapid rate between the

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[1] Both of the forms of increase in net farm income can be considered as resulting from larger scale operations but only the one results from lower costs.

[2] This statement is made on the basis of the type of accounting used in the study and upon the apparent linear correlation between work units and net farm income. Interest on capital and the wage of operators and family labor have not been deducted as costs. The linear correlation indicates that additional expansion in size would have been accompanied by increased net income. Of course it could be true that marginal costs and marginal revenue were equal in terms of the uncertainties which existed and the operator's resultant discounting of the future.

Table 25. Addition to net farm income due to lower costs alone and to greater volume alone, 1939 survey

Size interval in work units	Gross income	Cost per $100 gross income	Net farm income	Total increase in net farm income[a]	Increase due to lower costs alone[b]	Increase due to greater volume alone[c]
0-149	925	66.05	336	--	--	--
150-299	1844	57.11	865	529	165	364
300-449	3064	47.42	1712	847	296	551
450-599	4388	46.60	2518	806	36	770
600 & over	6454	48.54	3469	951	-125	951

[a] Increase for each size group over average of next smaller group.

[b] Computed by multiplying the units of $100 gross income for the size group by the decrease in costs per $100 gross over the next smaller size group. For example the increase due to lower costs for the 150-299 group is equal to (66.05 - 57.11) x 18.44 = $165.

[c] Increase in net farm income minus increase due to lower costs: For the 150-299 group this is equal to 529 - 165 = $364. Actually this method of computation attributes less to volume alone than would be true if costs were held constant as scale is expanded. This is true since the method employed allows a reduction in costs for both the original output and the additional output.

first size groups and at a slower rate between the third and fourth size groups. The table should not be misconstrued, however. The fact that the fourth size group had the lowest cost does not necessarily mean that the lowest cost per unit comes at an output of $4,388 gross or 511 work units. The discontinuity between groups hides the true point of lowest costs. The low point (as an average) may actually come either late in the 450-599 group or early in the 600 and over range. Too, the averages do not apply to each individual farmer. The low point for each depends on individual production situations. It may be true that a farm in the

300-449 group has extended operations to a point of equal marginal costs and revenue while an individual farm of over 600 work units may not have reached this point.

Returns from volume

It is evident that, within a certain limit, average costs tend to decrease as scale of operations increases. This results as indivisibilities of resources are overcome and as fixed costs are spread over a greater output. Beyond a certain point costs tend to rise because of a greater proportion of hired labor, greater purchases of feed and livestock, duplication of certain equipment and perhaps because of some management difficulties. But the most important finding of Table 25 is revealed in a comparison of the increased returns due to lower costs with those due to volume alone. Even had average costs remained constant (instead of decreasing) each of the first four size groups would have had a greater net income than that of the immediately smaller size group. The largest size group had a greater net income than the next smaller size group in spite of the higher unit costs.[1] In every case, the increase in net income due to volume alone was much greater than that due to lower costs alone. All of the income advantage of the largest size group over the next smaller resulted from volume and not from lower costs.

This relationship suggests several things of importance. It is of course true that income can be increased somewhat on the small unit

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[1] This has to be true as long as marginal cost is less than marginal revenue.

through cooperative use of machinery and equipment. Such practices tend to spread certain fixed costs over a greater output and divide the total between several farms. Too, the development of small machines and power units which cut down on the overhead costs represents another possibility of increasing income on the small unit. More can be added to income, however, by increasing the scale of operations. Although the two go hand in hand within a certain range of farm size, lower costs are not as important as greater volume.

Actually, cooperative use of machinery as a method of realizing the economies of large-scale production means relatively little to the very small unit. For example, suppose that farms in the 0-149 size group had cooperated to the extent that their costs were decreased to the low of the 450-699 size group. This would have meant a saving of $9.45 per $100 gross income but would have increased net income by only $84. On the other hand, costs and other things remaining equal, a $500 increase in volume of business would have meant a $170 increase in net income.[1] Obviously, the large farm has more income not so much because of its lower costs but because of the greater volume of business as such.

Farm Size and Returns from Owning Versus Renting

A problem which has to do with farm size arises when comparisons are made between returns on owned and rented farms. Some persons feel that

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[1] Assuming that costs per $100 gross income remain at $66.06 in order to show the advantage of size alone.

if one is to operate a small farm ownership will be more profitable than tenancy and that the reverse will be true for large farms. Others express an opposite opinion. In an attempt to throw some light on this question a comparison of net operator income on owned and tenant farms was made for the 1942 data.

Nature of relationships

On the basis of the data presented in Table 26 the tenant operators on small units had larger incomes than did owner-operators. As Figure 7 suggests this relationship held up to a scale of approximately 288 work units. Beyond this point the owner operator had greater net returns than did tenant operators.

Table 26. Regression of net operator income on farm size and related statistics, 1942 survey[a]

Tenure	Regression equation[b]	$s_{My'}$	s_b	Value of regression coefficient at 5 per cent fiducial limits	
				Upper	Lower
Owned	1.575X - 89.1*	23.45	.0949	1.762	1.388
Rented	.995X + 79.3*	16.58	.1099	1.212	.778

[a] Income in tens of dollars and size in work units.

[b] Differences between regression coefficients significant at the 1 per cent level of probability.

* Regression Coefficient significant at the 1 per cent level of probability.

Reasons for relationships

There are reasons why a relationship of the general nature suggested here should exist. It is true that addition to size of an owned unit adds more to income than for a rented farm regardless of scale of operations since rents must be paid out of the tenant's production. Yet the owner starts out with greater first costs since, as the holder to the title of the real estate, he has certain fixed obligations which are not incurred by the tenant. These costs include depreciation and insurance on buildings, taxes, and interest on the real estate mortgage if one exists. The tenant, unless he pays cash rent, has no such large fixed costs. Were both the owner and the tenant of the small farm to produce nothing and thus incur no operating costs, the owner would have a greater loss than the tenant since the latter would have only the annual non-variable costs associated with working capital while the former would also have fixed costs associated with land and improvements.[1]

It may seem that rents should rise high enough to place the tenant on the small farm in a position comparable to that of the owner in respect to income. This does not have to hold true. Fixed costs such as taxes must fall on the land owner (even if they are relatively high on the small unit due to the regressive nature of assessments). Neither must

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[1] Working capital usually designates such farm assets as machinery and breeding stock. Even though these were not used in production for a year the owner would still have some small costs in the form of taxes, obsolescence, insurance and perhaps interest.

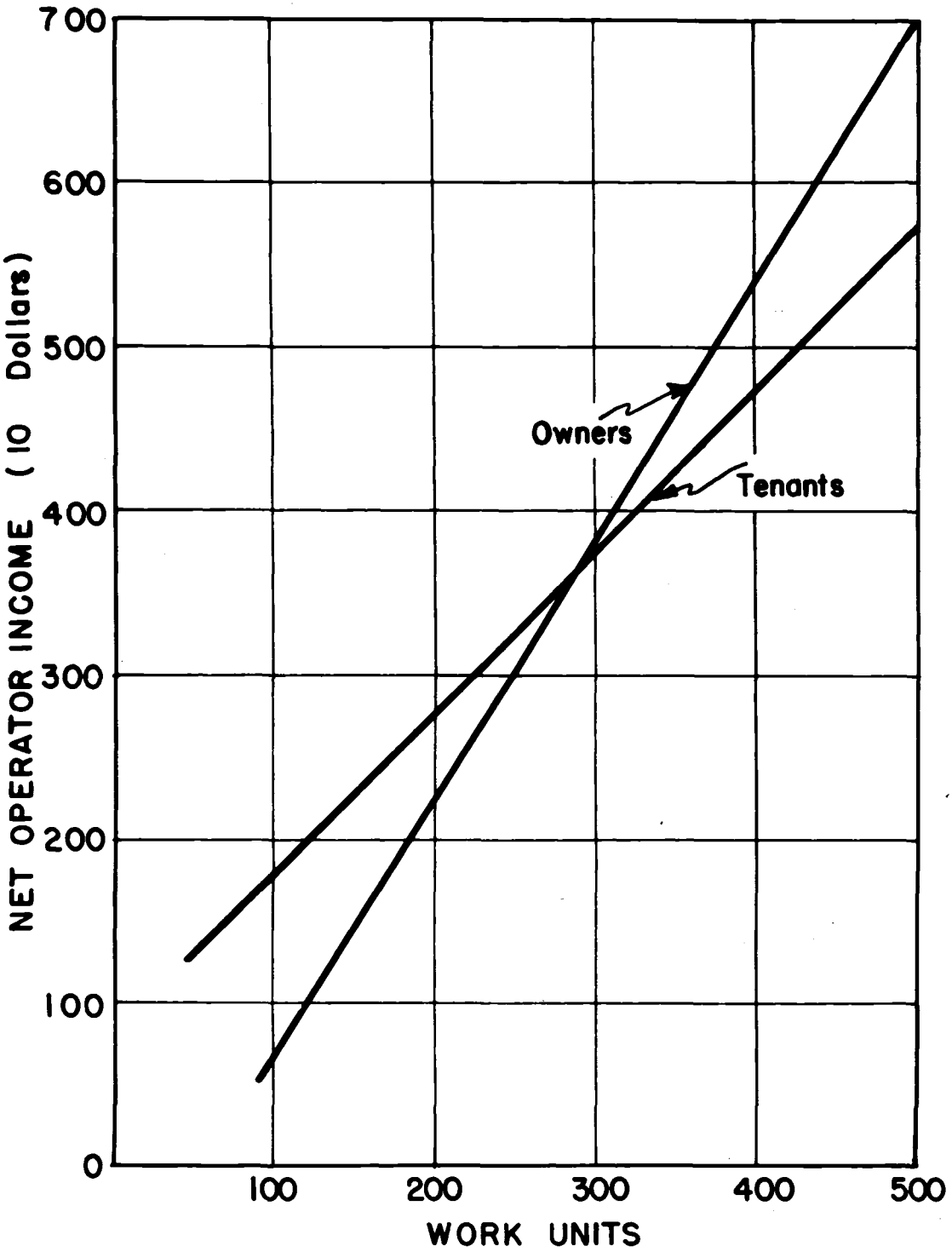

Figure 8. Comparison of operator income on owned and rented farms, 1942.

fixed costs which arise in the case of buildings and other reproductive resources which result in high unit costs for the small farm come to rest on the tenant. As long as the number of medium-sized and large farms is greater rents will not be determined by the level of costs on small farms.

It has already been indicated that, on the basis of the data presented herein, the point at which the owner farm exceeds the tenant farm in respect to operator income appears to take place at about 288 work units. However, it may well be that this point might fall at a smaller (or larger) scale. Even on the basis of the 5 per cent level of fiducial limits for each regression coefficient, this point might come at as few as 171 work units.

It is felt that although the relationships suggested herein appear reasonable on a basis of both statistical and economic analysis, the problem posed merits further research. An analysis should be made for farms of different types. More records should be used in order to reduce the sampling error and thus better suggest the true range within which the point of transition occurs. It may be that the analysis should be made with acres used as the standard of measure since under a predominance of crop-share leases rents are tied closer to land than livestock.

Productivity of Labor

The family has always been the chief source of labor on Iowa farms. This was true for the majority of farms included in the 1939 data. It

was true for large farms as well as for small farms. Table 27 indicates that both large and small farms used a greater proportion of family labor than of hired labor. However, the relative importance of hired labor increased with scale of operations. For example, the smallest farms used 13.5 months of labor but 96.7 per cent of this was family labor. The farms in the size group 300-449 used 22.8 months of labor, 86.0 per cent of which was family labor while the largest farms used 32.6 months of which only 62.5 per cent was family labor.

Table 27. Use of family and hired labor, 1939 survey

Size interval in work units	Total labor		Family labor		Hired labor	
	Months	Per cent	Months	Per cent	Months	Per cent
0-149	13.5	100.0	13.0	96.3	.5	3.7
150-299	17.4	100.0	15.9	91.4	1	8.6
300-449	22.8	100.0	19.6	86.0	3	14.0
450-599	27.3	100.0	19.6	71.8	7	28.2
600 & over	32.6	100.0	20.4	62.6	13	37.4

The greater proportion of family labor employed is one important reason that the small farm with its meager income can exist side by side with the more efficient large-scale farm, or that the medium-sized unit is not forced to liquidate as is sometimes true in other industries. A sizeable portion of the labor used on many Iowa farms comes at practically no cost to the farm business. Part of it represents the work of teen-aged and school children or that of the housewife. This labor has few if any alternative opportunities for employment. It does not ordinarily show up as an expense in the farm's accounts because it does not receive a fixed

and established wage. If income is favorable the son, for example, will have more spending money. If income is unfavorable he receives less. However, as operations are expanded this flexibility in labor costs tends to become less. More hired labor must be taken on at a definite cost to the business.

The increase in labor costs which accompany greater scale of operations should in part offset other economies of large scale. This does not hold true, however, because the large unit utilizes its labor more effectively. As Table 28 indicates, productivity of labor tends to parallel size of operations. In 1939 farms in the middle sized group produced 93 per cent more work units per year-round worker than did the small-sized group but only 55 per cent as many as the large size group. The greater labor costs on the larger farm tend to be more than offset by the greater output per worker.

Table 28. Work units produced per man equivalent, 1939 survey

Size interval in work units	Total work units	Man equivalent[a]	Work units produced per man equivalent
0-149	96.0	1.13	85.0
150-299	229.9	1.45	158.6
300-449	386.7	1.90	193.0
450-599	511.0	2.28	224.1
600 & over	782.3	2.72	287.6

[a]Total months labor from Table 26 divided by 12.

The less effective use of labor on the smaller units can not be entirely attributed to the choice of the operator. Rather it is often a necessary condition growing out of the scale of operations or factors conditioned by size. There are several reasons why more is accomplished per worker as the size of the unit increases. The larger farm simply has more work to do. The operator of the small farm, although willing to do additional work, often lacks the capital necessary to add or expand profitable enterprises; otherwise he would more often do so. The greater investment in capital, especially machinery and other labor-saving equipment, per worker makes it possible to accomplish more in a given amount of time. Larger crop and livestock enterprises do not require a proportionate increase in labor requirements. For example, the amount of labor is not doubled as the hog enterprise is increased from 5 to 10 litters or less time is spent per acre in cultivating a large field than a small field. Irregularly shaped fields on very small farms require more time for field operations. It is also true that a greater proportion of the operators of very small farms are of advanced age, in poor health or otherwise incapacitated for heavy labor. Even when allowance is made for differences in age and physical condition of workers, farms with a small volume of business use labor less effectively.

A certain number of persons operate small units simply because they wish to or can do little physical work. Especially included here is a group of semi-retired farmers and others who can not stand the physical strain of greater effort. Probably a greater number of farm operators, however, desire to use their labor more remuneratively. One method of

accomplishing this, where small scale operations prevent full use of labor, is through off-farm employment. This opportunity is not great in Iowa due to the lack of industrialization. The productivity and effectiveness of farm labor in Iowa hinges largely around scale of operations. This greater productivity of labor which accompanies greater scale of operations can not be brought about unless the necessary amount, and in turn, the proper forms of capital are available. The two problems, effective utilization of labor and availability of capital, are quite largely inseparable problems in agriculture. The interrelationship between efficiency in the use of labor and availability of capital is often times overlooked by farm management research workers. Some persons sort their farm records by size, show that income is greater on the larger farms, re-sort their records on a basis of efficiency in labor utilization and show a similar relationship between efficiency and income. These studies often imply that one simply has to increase labor efficiency to increase income. Actually, the group of farms showing the highest income in a farm size sort is roughly coincident with the high income group in a labor efficiency sort. Therefore, the great step-up in labor efficiency cannot be brought about unless size is increased. Size, in turn, cannot be increased unless the necessary capital is available.

Labor efficiency also varies with other factors not directly related to size. For example, more can be accomplished in a given amount of time if chore work is well routed, if gates, doors and feed bins are conveniently placed and if similar considerations are given to the planning

of the work. Yet there is no monetary premium on this method of increasing labor efficiency if scale of operations are small. As long as the operator is not busy full time and does not have outside employment, he has no less income if he spends a greater amount of time on routine work. Only when there are profitable alternatives for the use of labor can an operator increase his net income through employment of such labor-saving methods as those mentioned. Hence, even this means of labor efficiency may be indirectly related to farm size and availability of capital.

Even though availability of capital is a crucial factor, the operator with limited resources still has some power to control the effectiveness of labor utilization. He has the choice between operating a small owned unit or a larger rented unit. The former will mean a less efficient use of labor than the latter. It would be meaningless to suggest the larger rented unit as a means of utilizing labor more efficiently if such had to come at the expense of income. However, as was pointed out previously, the larger rented farm will, within limits, mean a greater operator income than a small owned unit not only because of lower costs but also because of greater volume alone.

Combination of Resources

A constituent of the farm income-farm size complex is the combination of resources. A premise of economic theory, closely related to that of the optimum-sized firm, is that of the optimum combination of productive factors. It has already been noted that the unit of optimum size (from

either the cost or net income standpoint) is the exception rather than the rule in agriculture. How does this, in turn, affect the combination of resources?

The combination of resources is definitely affected by the size of the unit in agriculture. Table 29 bears out this statement. The value of all capital per worker tends to vary directly with farm size. This relationship between farm size and resources also exists for the amount of land per worker and the value of equipment per worker. On the other hand, the investment per acre of land in such assets as buildings and machinery takes on an opposite relationship. The smaller the scale of operations the greater the relative investment. The resource combination outlined above has a two-fold impact on income. In the first place, the

Table 29. Combination of specified resources, 1939 survey

Size interval in work units	All capital per worker (dollars)	Acres per worker	Equipment per worker (dollars)	Building investment per acre (dollars)
0-149	2909	51	207	38
150-299	4286	88	513	28
300-499	4984	98	713	26
500-599	5361	103	725	25
600 & over	6199	122	879	22

combination of too little capital and land per worker results in a low productivity per worker on the small farm. The second effect has to do with costs. The greater investment in buildings per unit of crops or livestock tends to result in greater fixed cost per unit of output.

The choice of resource combination is far from arbitrary on the small farm. It is not entirely a matter of management. It is partly molded by the fact that the unit is small. Only as capital becomes available and as size is increased can the indivisibilities of resources be overcome thus allowing a more remunerative combination of resources.

Income attributable to labor

The operator of the small unit is mainly selling the labor of himself and his family in the form of agricultural products. The major part of his net income represents the product of labor. Of course, as an owner of other resources he can claim their net product as part of his income. However, the contribution of these non-human resources is relatively small. As Table 30 suggests, operators of very small units did not even realize

Table 30. Value of unpaid family labor as a percentage of net farm income, 1939 survey[a]

Size interval in work units	Value of unpaid family labor as a per cent of net farm income	
	1939	1940
0-149	180.6	72.3
150-299	92.4	39.8
300-499	59.4	27.1
450-599	48.9	18.6
600 & over	41.2	12.2

[1]Computed by multiplying months of family labor used by average monthly wage rates and dividing this figure by the net farm income.

the wage of a hired man in 1939.[1] The relative share of net farm income

[1]It may be that the value of the family labor on small farms is less than that on other farms due to a greater number of older operators. However, were it possible to make adjustments for quality of labor relationships similar to those indicated in Table 29 would undoubtedly still exist.

attributable to labor was less than in 1939 on small farms as well as on large farms but the same relationship to size still existed.

Returns to management

The return of the fourth factor of production, management, also constitutes a part of this income. A small amount of data on management return is included in Table 31. This study, like most farm management studies, indicates greater returns to management on larger farms. A

Table 31. Relationship of management return and farm size,[a] 1939 and 1942 surveys

Size interval in work units	Returns to management (dollars)	
	1939	1942
0-149	-479	548
150-299	-295	1329
300-449	- 70	2940
450-599	568	4911
600 & over	758	8621

[a] These figures were computed in the manner common to most farm management studies. The estimated returns to land, capital and family labor have been subtracted out of net income to give the residual which is usually termed management return. Obviously, this figure may include much beside the return attributable to management. In 1942, for example, a large component of this return included a windfall profit arising from the changes in price-cost relationships. This figure can be used in a rough way, however, to compare efficiency of operations between farms. It cannot be used satisfactorily to compare efficiency for one farm in different years or between types of farms for only one year.

part of this so-called management return cannot be attributed to management as such. Two of the several reasons that management returns are greater

on large farms than on small farms are the lower costs per unit of production and the greater productivity of labor. The greater management return due to these two factors can hardly be attributed entirely to managerial ability. Instead the ability to take advantage of these economies and hence increase the so-called return to management often rests on whether or not capital is available for expansion of operations. The young operator on the small unit may well be equal to the operator on the large unit as a manager. The reason he does not expand, lower costs and increase productivity of labor is not always due to lack of managerial ability. It may be lack of available capital instead which prevents such operators from combining resources in a more productive manner and thus from capturing a greater share of this income constituent commonly confounded with management returns.[1]

Size of Farm and Family Characteristics

The existence of some small farms has a certain basis of merit. This is suggested in the data of Table 32. The very small and moderately small units tend to be operated by a relatively large proportion of very young and old men. As the size of farm increases through medium-sized and moderately large units the percentage of both old and young operators

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[1] The different forms of capital limitation have been discussed in detail in an earlier section of this study. The capital limitation may (1) be imposed by credit agencies or (2) be self-imposed by the farm operator since he does not have knowledge of profitable investments or refrains from using credit because of uncertainty or family beliefs. It is the first of these which is being considered above.

tends to decrease. The very large units are operated mostly by middle-aged or old men.

Table 32. Percentage distribution of operators by age groups and farm size, 1942 survey

Size interval in work units	Age group*			
	0-30	31-59	60 & over	All groups
0-149	18.7	67.6	22.7	100.0
150-299	15.5	66.7	16.8	100.0
300-449	9.3	78.2	12.5	100.0
450-599	7.2	83.7	9.1	100.0
600 & over	3.2	75.8	21.0	100.0

*Differences between groups significant at the 5 per cent level of probability.

This age distribution represents various stages in the farm operations cycle. The small unit presents an opportunity for the young man with limited capital who wishes to begin farming. Were it necessary to start with an average-sized unit or none at all, many could not become farm operators. Too, the small unit is often a haven for the older man who does not wish to curtail his activities completely or for the physically incapacitated operator who wishes to farm but can not stand a great deal of heavy work. The medium-sized to moderately large units are operated mainly by middle-aged men since the capital requirements are too great for the young operator who must start out on his own or with only a small amount of help from others. The greater number of older men on the large unit may partly result since this represents an accumulation of those who have either not retired entirely or to a small unit. (Part may also

represent a sampling variation). Again, the capital requirements of the very large unit are beyond the assets owned by the young farmer unless he has inherited or has otherwise been the recipient of a fairly large sum.

It is well that some small units exist for the very purposes suggested above. The young beginner should not be expected to have an income on a par with that of an older operator. The semi-retired farmer does not always depend on the earnings of the small unit he operates. It may well be that he is operating only part of the land he owns or that he has income from other savings.

Actually, the entire problem of farm size and its relationship to farm income and family living touches upon sociological as well as economic spheres. For example as Table 33 indicates, the family on the small farm tends to include fewer persons than that of the larger farm. This is tied to the fact that the small-scale operator is more often a young man with only a few small children or an old man whose family is grown.

Table 33. Percentage distribution of family by size and farm size, 1942 survey

Size interval in work units	Number in family*	
	1-4 persons	5 or more persons
0-149	87.4	12.6
150-299	84.4	15.6
300-449	74.6	25.4
450-599	63.5	36.2
600 & over	61.8	38.2

*Differences between groups significant at the 1 per cent level of probability.

It is evident that size of farm does not have the same meaning to all farm families. Some families can exist on a unit which might be considered as less than minimum from the average income standpoint. Obviously, families of two persons can be expected to make a living on a smaller unit than families of six persons. Young couples with small children will not require the same income for family living as will a family of the same size with older children. They will, of course, need a larger unit as the number in the family increases and as greater expenditures are required for growing children. Older couples with no children, or only grown children, can be looked upon as retirement cases rather than as operators which should or will increase scale of operations. As was indicated earlier, some persons on small units may not have the managerial ability to take on larger units. All such factors should be considered before adjustments are suggested to individual operators or before policies affecting farm capital and farm size are activated.

Farm Size and Capital Employed

The availability of capital is an important factor conditioning farm size and hence operator income in Iowa. This is apparent from the data presented in Table 34. Although the data of Table 34 are for all farms, similar relationships held for farmsgrouped by type-of-farming areas, type of farm and by tenure. Statistically, the correlation between work units and total capital was highly significant in each instance.

The figures in Table 34 roughly indicate the amount of capital required for owner or tenant operation of various sized units. The total

figure represents that required for the owner since he must invest in both working and fixed capital. The figure for working capital indicates that necessary for the tenant (except in cases of stock-share and similar rental relationships) since he does not invest in fixed capital. Not only may the tenant of the small unit realize a greater income than the owner-operator of a like unit, as was pointed out in an earlier section, but he can also operate a larger unit with a given amount of capital. This is a point which should be considered either by the prospective farmer or those who are concerned with settling people on the land and with formulating land tenure policies. It may well be more profitable for the person with limited capital to rent a medium-sized farm rather than to own a small farm. Certainly this is true within a certain range of farm size on the basis of data presented in Table 26.

Table 34. Relationship between farm size and specified types of capital, 1939 and 1942 surveys (dollars)

Size interval in work units	1939 survey		1942 survey	
	Total capital	Working capital	Total capital	Working capital
0-149	6387	1115	6207	1668
150-299	15882	2441	15217	4022
300-449	22193	4446	26583	6812
450-599	30258	6086	32697	9024
600 & over	42089	9600	48753	13904

Capital requirements by type of farm

An indication of the capital required for farms of different types and sizes is to be had from Figure 8 and Table 35. The total capital

Table 35. Regression of capital on farm size by type of farm, 1939 survey[a]

Type of farm	Regression equation	$s_{by.x}$	s_{My}
Cattle feeding	126.6 + .37 X*	.088	20.952
Crop	1.5 + .70 X*	.086	10.822
Dairy	7.5 + .49 X*	.045	7.089
Dual	12.0 + .57 X	.070	15.004
General	-10.8 + .61 X*	.082	5.149
Hog	45.7 + .45 X*	.038	6.355

[a]Total capital in hundreds of dollars and size in work units.

[b]Differences between regression coefficients significant at the 1 per cent level of probability.

*Regression coefficient significant at the 1 per cent level of probability.

investment for a unit of given size, as measured in work units, is lower for dairy farms than for other types. The investment for the crop farm tends to be greatest. Or conversely, a given amount of capital will support a larger dairy unit than other types of farms. For example, a $15,000 investment would, on the basis of price levels existing in 1939, allow a scale of 291 work units for a dairy farm, 310 for a hog farm and 212 for a crop farm. These relationships are obviously tied closely to the labor requirements for the enterprise under consideration. The investment of $150 in two dairy cows valued at $75 each would call for around 280 hours of labor per year. The same investment in three acres of land valued at $50 per acre would, on the average, call for around twenty-one hours of labor if the land were planted to oats or forty-eight hours if planted to corn.

At the level of a $15,000 investment, the scale of a cattle feeding farm would be less than for any other type of farm on the basis of the computed regressions. The number of work units possible at 1939 prices would be only sixty-three for this type of farm. However, due to the values of a and b in the regression equation, an investment of $45,000 would allow a cattle feeding farm on a scale greater than for crop, dual purpose and hog farms and nearly as large as for dairy and general farms. These figures suggest that a large initial investment is required for the cattle-feeding farm but that, after this initial investment, additional size can be added at only a small investment. Several things cast doubt especially upon the level and, to some extent, on the slope of the regression line for cattle-feeding farms. No great investment in land or equipment is required for cattle-feeding operations. Certainly the necessary investment in equipment is less than for dairy cattle. The investment in land required per work unit of feeder cattle is less than that for crops. Finally, as Table 35 indicates, the errors of estimate are greater for cattle-feeding than for other types of farms. Even within sampling limits the true population regression for cattle-feeding farms could vary much more from the computed regression than for most other types of farms studied.

Capital requirements and returns by type-of-farming areas

Some persons feel that with limited capital it is better to invest in an area of low-priced land since this will allow a larger unit than

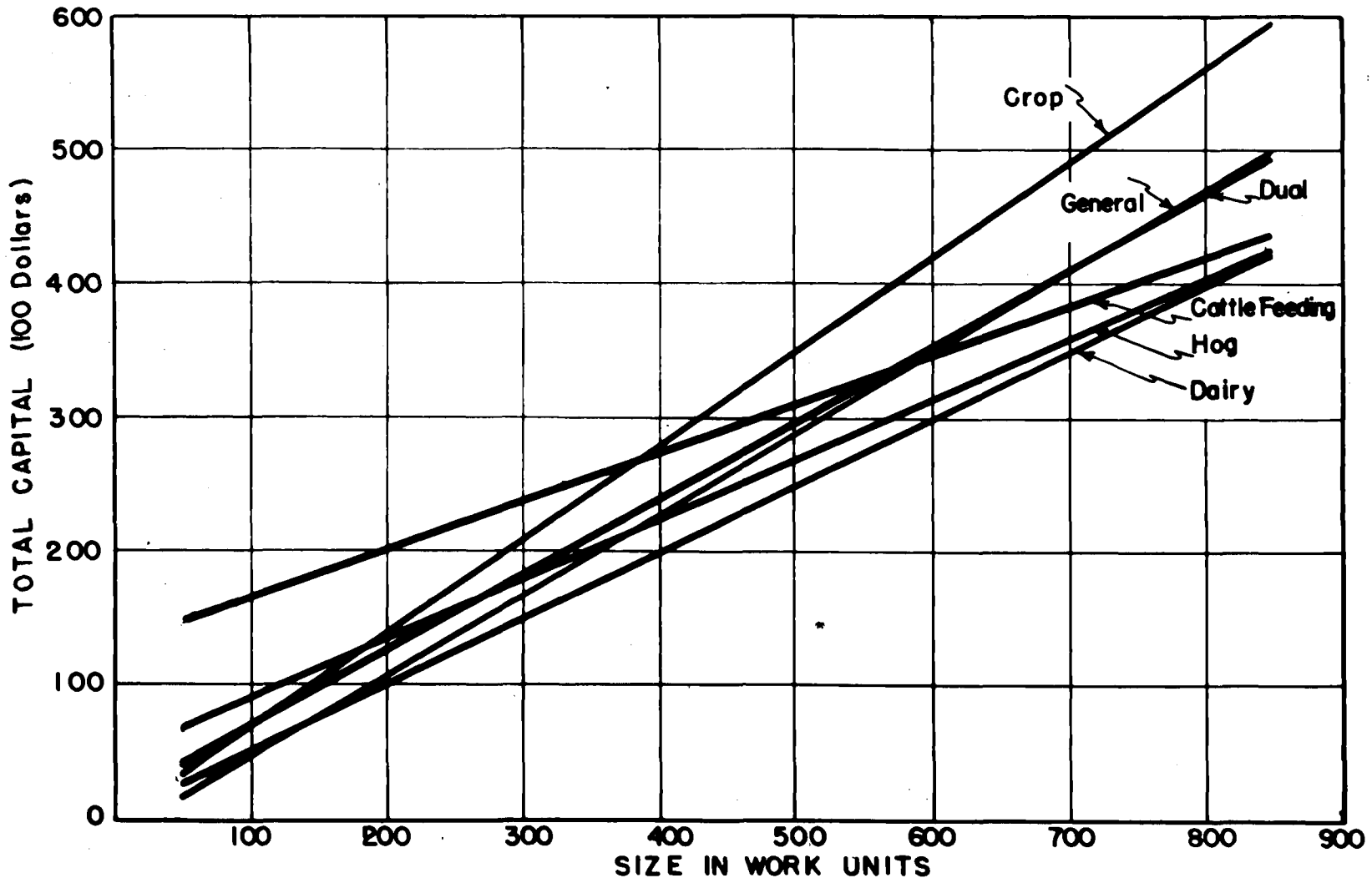

Figure 9. Capital requirements by type of farm, 1939.

will a like investment in an area of high-priced land. This is true between type-of-farming areas in Iowa as can be seen from the data in Table 36 and from the relationships expressed in Figure 9. A given amount of capital will support a large physical unit in the Southern Pasture area of Iowa since the value of land is low relative to other areas. Similarly, the investment required for a given number of work units in the Northeast Dairy area is less than for the three remaining areas, partly because of lower land values but also because labor requirements per investment in dairy cows are high. The investment per work unit in the Cash Grain area is high due to the fact that land values are high and also to the fact that cash grain farming is important relative to livestock in the area. Labor requirements are low relative to the total capital investment required for crop production in Iowa.

Table 36. Regression of capital on farm size by type-of-farming area, 1939[a]

Area	Regression equation[*]	$s_{by.x}$	$s_{My'}$
Northeast Dairy	40.1 + .428 X*	.0287	5.3005
Cash Grain	62.8 + .546 X*	.0367	7.5769
Western Livestock	28.2 + .539 X*	.0393	8.0082
Southern Pasture	-1.8 + .468 X*	.0292	4.8158
Eastern Livestock	7.0 + .572 X*	.0377	7.1986

[a] Total capital in hundreds of dollars.

[*] Differences between regression coefficients significant at the 1 per cent level of probability.

*Regression coefficient significant at the 1 per cent level of probability.

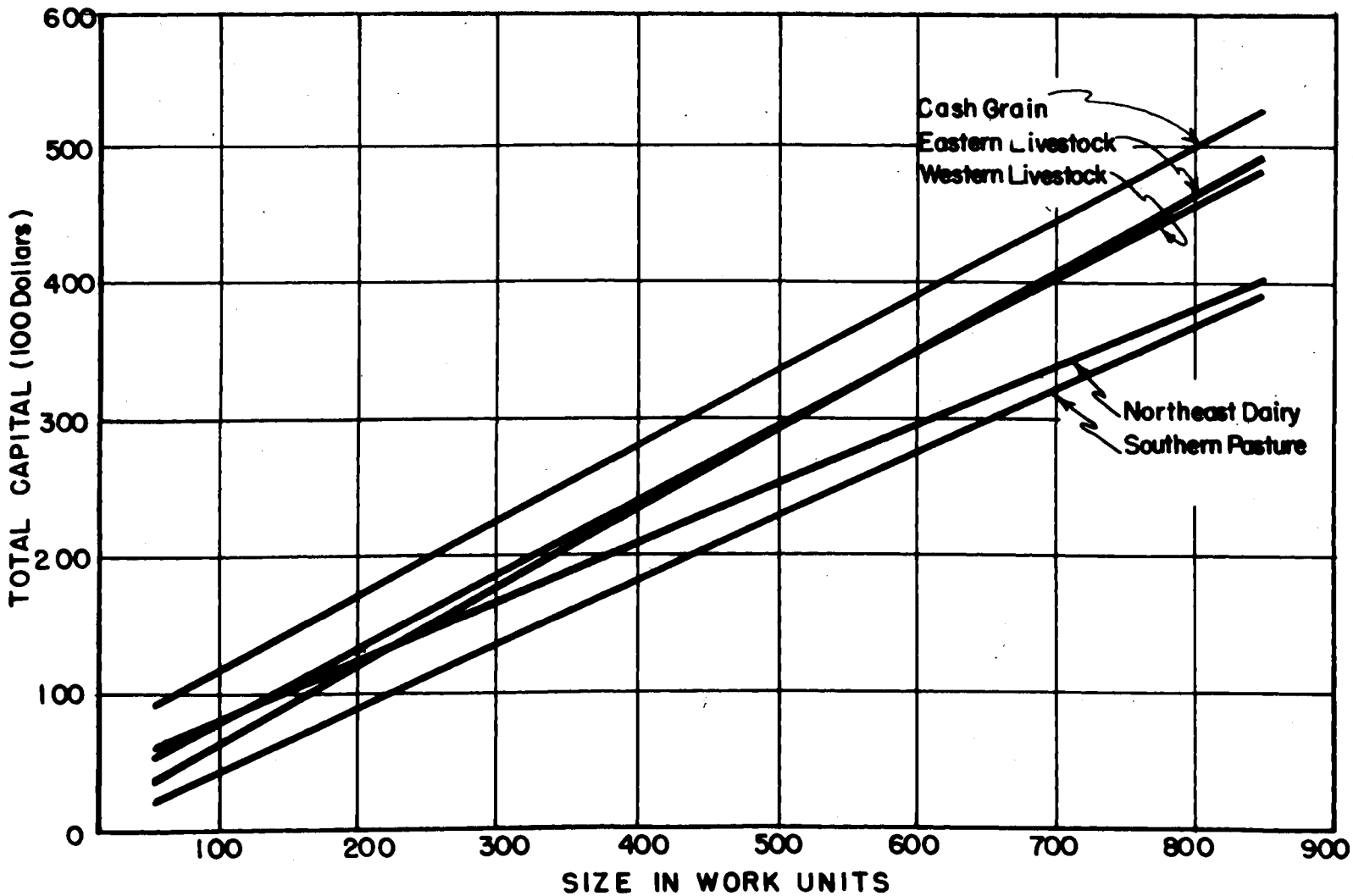

Figure 10. Capital requirements by type-of-farming area, 1939.

More important than the physical scale of operations which can be supported from a given investment in areas of various land values is the return forthcoming from the investment. Although a given amount of capital will purchase a larger unit in the Southern Pasture area, will it, for example, return a greater income than a like investment in the Cash Grain area?

In an attempt to throw some light on this question a comparison of the regression of income on capital has been made by type-of-farming areas. The relevant statistics are included in Table 57. According to these data the returns from a given amount of capital tended to be smallest in the Southern Pasture area and the Cash Grain area, the areas of lowest and highest land values. Further, the returns in the Cash Grain area were considerably less than for the Southern Pasture area.

Table 57. Regression of net farm income on total capital investment, by areas, 1939 survey[a]

Area	Regression equation[z]	$s_{by.x}$	$s_{My'}$
Northeast Dairy	8.259 X - 103.8*	.550	56.093
Cash Grain	5.203 X + 537.3*	.623	91.615
Western Livestock	8.402 X - 61.5*	.815	126.713
Southern Pasture	7.190 X + 109.8*	.620	56.535
Eastern Livestock	7.383 X + 43.5*	.594	79.843

[a]Capital in hundreds of dollars.

[z]Differences between regression coefficients significant at the 1 per cent level of probability.

*Regression coefficient significant at the 1 per cent level of probability.

These relationships suggest that land is relatively over-priced in areas of both high and low productivity. If land were capitalized according to its earning ability this relationship would not hold. It is entirely possible, however, that the competition for land both high and low in productivity is great enough to drive the price above the earning power. The discrepancy might arise in the high value areas because of the individual's pride in owning high-producing land and in the low value areas because of the numbers of persons who wish to buy farms with a small amount of capital.

The above analysis may be a first approximation of the true relationship between type-of-farming areas. It may also be true that the relationships suggested herein are confounded with others if land value groups alone were to be considered. For this reason the problem posed merits further study. Data from several years should be studied in order to avoid price relationships which favor any one value group. Too, relationships might be more clearly isolated if land value groups were delineated not by type-of-farming area but by other criteria.

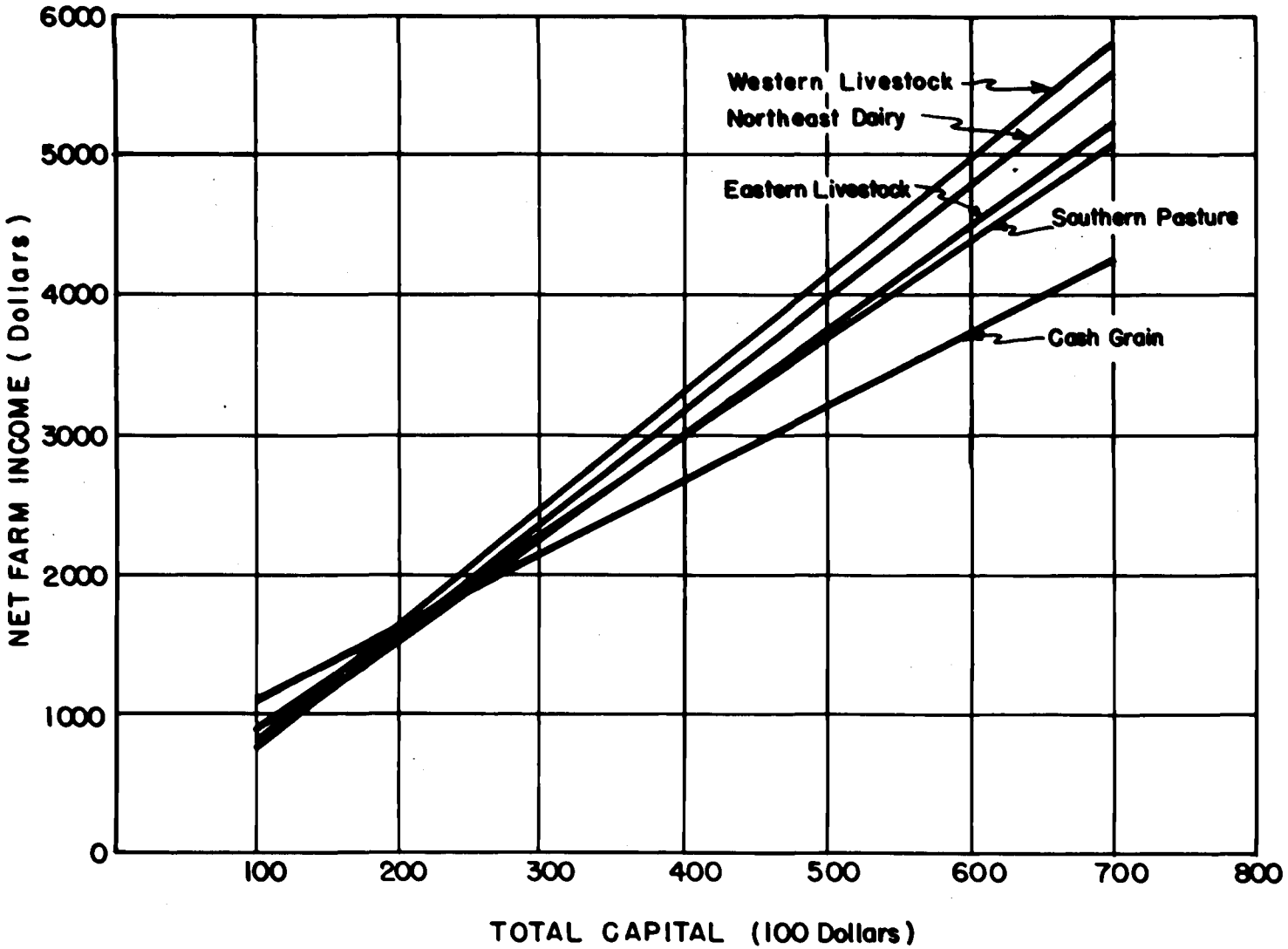

Figure 11. Relation of net farm income to capital investment by type-of-farming area 1939.

SUMMARY AND CONCLUSIONS

Farm Size Adjustments

Many predictions relative to farm size adjustments have been made over the past two decades. These predictions, revolving around mechanization and implying the static theory of the firm, have suggested large increases in the number of acres per farm. However, there is little evidence that the change in farm size has been as great as was commonly expected. Changes have often been greater in areas where mechanization has not been important than in highly mechanized areas.

A consideration of the non-static theory of the firm throws some light on why adjustments have not been as great as might be expected. Yet any analysis of farm size adjustments must consider additional factors which are peculiar to agriculture and which are not included in the assumptions of the theory of the firm: (1) Capital is not so readily assemsible as is assumed in the theory of the firm. The farm operator tends to push scale of operations to that which is possible in terms of the capital he owns and can (or is willing) to borrow. (2) The farm includes the household as well as the firm. The labor is mainly that of the family and often does not receive a definite wage. The farm represents a hard-won home which the family is reluctant to leave. (3) The firm in agriculture is a one generation affair. The process of capital accumulation

must start over with each generation. (4) The market for productive factors is highly imperfect. It is impossible to add acres to one farm plant except as other farmers relinquish operation of their units. Even then the unit made available is not always of a desirable size and location and obtainable at reasonable terms. (5) The typical farm operator will remain on the farm as long as the returns from all his resources compare favorably with thosewhich he might earn for his labor elsewhere or as long as he is able to meet commitments.

Within this framework of conditions, mechanization may or may not force larger units. It makes possible the operation of more acres with the same amount of labor and similar amounts of capital. However, one operator cannot increase his acreage until additional land becomes available. Hence, two general cases can be established: (1) If mechanization encourages a greater acreage of the crop the price of the commodity will drop and the income of the small-scale operator who retains the old technique will be less than formerly. This lower income will encourage some small-scale operators to turn to other occupations. The remaining operators can then expand their acreage. (2) If the mechanical development is not accompanied by a greater acreage of the crop there will be no such tendency toward an increased farm size. The operator of the small unit will still have as great an income as formerly and as long as he remains in farming his unit cannot be consolidated with others. The outcome may, of course, vary with tenure arrangements.

Other factors may be equal to or greater than mechanization as forces bringing about farm size adjustments. Any factor which tends to lower incomes will force some operators from their units and may thus make possible the consolidation of farms. The outcome will again vary with tenure arrangements.

In Iowa the greatest single adjustment in farm size took place soon after the state was settled. The original modal unit was the 320 acre claim of the "squatter". The modal size dropped to 160 acres once sale of the public domain was initiated. For the eighty-year period, 1840-1920, the trend in farm size was mainly in the direction of medium sized units.

Since 1920 there has been a very gradual trend toward larger units. Mechanization has been the development making possible this trend although it has not always been the initiating force. The number of consolidations has not been as great as many have supposed and it appears unlikely that mechanization will revolutionize the size of Iowa farms in the next several decades.

The pattern of farm size adjustments has varied by type-of-farming areas in Iowa. There has been little or no change in the Northeast Dairy area. The greatest number of consolidations has taken place in the Southern Pasture and Western Livestock areas. Some consolidation has taken place in the Cash Grain and Eastern Livestock areas although the number has not been great. If mechanization had been the causal factor the pattern of adjustment should have been greatest in the level areas and least in the rough areas of the state. It appears that although

mechanization has made possible larger units, other factors such as drought and depression have been the forces initiating the adjustments in Iowa.

Relationship of Income to Farm Size

An analysis of farm income data for 1939 and 1942 sample surveys indicates a statistically significant correlation between net farm income and farm size as measured in work units. Farm size explained 50.5 per cent of the variance in farm income for all farms in 1939 and 52.5 per cent in 1942. The correlation between farm size and farm income varied for farms grouped by types. It was greatest for dairy and crop farms and lowest for cattle-feeding farms.

The relationship between income and size was one of constant returns to scale for all types of farms and all type-of-farming areas except the Cash Grain area. The relationship appeared to be one of decreasing returns for this area. Although the relationship may be one of constant returns to scale for all farms taken together the relationship may well vary for different intervals of farm size.

The over-all farm organization and the efficiency of operations of small farms was comparable to that of large farms. However, not all persons are equally able to manage a large farm. The scatter of incomes was much greater for farms in the large size interval than for farms falling in the small and medium size interval.

The size of the farm has far-reaching effects on the combination and productivity of resources employed by the farm operator. The large

farm has a greater total capital, more working capital and more land per worker than does the small farm. The productivity per worker thus parallels the size of the farm. Conversely, the investment in improvements per given area of land tends to be greatest on the small farms. This relationship results in higher fixed costs per unit of output on the small farms.

As the size of the farm increases net farm income increases for two reasons: (1) Certain economies are realized and average costs are lowered as resources are combined more efficiently. (2) The additional volume of business increases net income as long as total expenses do not increase by a like amount. The analysis of the 1939 data indicates that the large farm has a greater income not so much because of its lower costs but because of its additional volume of business.

The analysis of the 1942 data indicates that small tenant-operated farms have greater income than small owner-operated farms. This relationship holds true on small farms since the owner-operator incurs certain fixed costs which are not covered by the rent of the land.

Small units tend to be operated by beginning farmers who do not have the capital for larger units and by older men who are physically unable to operate larger units. A number of small farms is justifiable in that these persons are given an opportunity to carry on operations.

Availability of capital is the most important factor limiting scale of operations on Iowa farms. It is not until sufficient capital is

available that the operator can expand operations and combine resources in the most economic manner. The size of the unit which can be supported with a given amount of capital depends, of course, on the type of farm and the type-of-farming area selected by the operator.

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APPENDIX

Table A. Changes in size of farms by region and tenure groups in the United States, 1920 to 1940

	Tenant farms			Owner farms*		
	Average acres		1940 as per cent of 1920	Average acres		1940 as per cent of 1920
	1920	1940		1920	1940	
Corn[a]	157.3	148.0	107.8	101.8	95.5	93.8
Eastern dairy[b]	111.0	107.5	96.8	90.9	89.1	98.0
Western dairy[c]	154.6	149.9	97.0	111.5	106.4	95.4
Eastern cotton[d]	50.1	68.6	136.9	117.4	114.1	97.2
Delta cotton[e]	38.4	46.0	119.7	115.2	101.4	88.0
Western cotton[f]	133.3	182.0	136.5	245.0	226.0	92.2
Small grain[g]	304.4	346.1	113.7	218.9	284.9	130.2
Range[h]	374.5	461.6	123.3	317.8	406.2	127.8

Source: United States Census.

*Full-owners

[a]Illinois, Indiana, Iowa and Ohio.

[b]Connecticut, Massachusetts, New Hampshire, New York, Pennsylvania and Vermont.

[c]Michigan, Minnesota and Wisconsin.

[d]Alabama, Georgia and South Carolina.

[e]Arkansas, Louisiana and Mississippi.

[f]Oklahoma and Texas.

[g]Kansas, Montana, Nebraska, North Dakota, and South Dakota.

[h]Arizona, Idaho, Nevada, New Mexico and Utah.

Table B. Number of all farms by size distribution, Iowa, census years 1880-1940

Size group in acres	1880	1890	1900	1910	1920	1925	1930	1935	1940
0- 19	5,529	5,550	11,648	13,724	11,531	13,125	15,522	18,821	16,622
20- 49	25,488	18,418	21,475	15,676	13,117	12,593	12,178	13,815	12,003
50- 99	50,519	53,345	49,665	38,712	35,959	34,528	32,209	34,285	32,146
100-174	a	a	a	80,121	85,594	86,375	84,722	84,917	82,393
175-359	95,163[b]	121,003[b]	142,676	40,304	41,414	41,475	42,615	42,342	41,462
260-499	a	a	a	25,861	23,865	23,503	25,546	25,619	26,119
500 & over	2,662	3,586	3,158	2,644	2,014	1,893	2,138	2,198	2,583
All farms	185,361	201,903	228,622	217,044	213,439	213,490	214,928	221,986	213,318

Source: United States Census.

[a] Data not available.

[b] 100-499 inclusive.

Table C. Percentage distribution of all farms by size, Iowa, Census years 1880-1940

Size group in acres	1880	1890	1900	1910	1920	1925	1930	1935	1940
0- 19	3.0	2.7	5.1	6.3	5.4	6.1	7.2	8.5	7.7
20- 49	12.7	9.2	9.5	7.3	6.1	5.9	5.7	6.2	5.7
50- 99	31.6	26.4	21.7	17.8	16.8	16.2	15.0	15.4	15.1
100-174	a	a	a	36.9	40.1	40.5	39.4	38.3	38.6
175-259	51.3[b]	59.9[b]	62.4[b]	19.8	19.4	19.4	19.8	19.1	19.4
260-499	a	a	a	10.7	11.2	11.0	11.9	11.5	12.3
500 & over	1.4	1.8	1.3	1.2	1.0	.9	1.0	1.0	1.2
All farms	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: United States Census.

[a]Data not available.

[b]100-499 inclusive.

Table D. Numbers of farms 0-19 acres in size, by type-of-farming area in Iowa. Census years 1920-1940

Area	1920	1930	1940
Northeast Dairy	2,277	2,304	2,701
Cash Grain	1,972	3,095	3,575
Western Livestock	1,836	2,911	3,237
Southern Pasture	2,273	3,076	3,287
Eastern Livestock	3,163	4,136	3,822

Source: United States Census

Table E. Work unit conversion factors*

Crop	Work units per acre	Livestock	Work units per acre
Barley	.7	Beef cow	3.0
Corn for grain	1.6	Dairy cow	14.0
Corn for silage	2.2	Feeder cattle	2.5
Flax	1.0	Young stock	2.5
Oats	.7	Fall litter	4.2
Soybeans for grain	1.0	Spring litter	4.0
Soybeans for hay	1.2	Sheep	.6
Wheat	1.0	Turkey	.37
Alfalfa	1.9	Hens (100)	17.0
Mixed hay	.8	Chickens (100)	3.0
Sorghum hay	1.7		
Wild hay	.5		

ACKNOWLEDGEMENTS

The author is indebted to Dr. W.G. Murray for suggesting the study and for guidance throughout its progress. The comments of Professors Kenneth Boulding, O.H. Brownlee, H.B. Howell, E.D. Ross, G.W. Snedecor and Gerhard Tintner have been very helpful in the analysis.